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FINAL SAMPLING AND ANALYSIS PLAN SITE 7 EXPANDED REMEDIAL INVESTIGATION
NWS YORKTOWN VA
8/1/2012
CH2M HILL

Final

Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) Site 7 Expanded Remedial Investigation

Naval Weapons Station Yorktown
Yorktown, Virginia

Naval Facilities Engineering Command

Prepared for

Department of the Navy

Naval Facilities Engineering Command Mid-Atlantic

Contract No.
N62470-08-D-1000
CTO-WE29

August 2012

Prepared by

CH2MHILL

SAP Worksheet #1—Title and Approval Page

Final

Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) Site 7 Expanded Remedial Investigation

Naval Weapons Station Yorktown Yorktown, Virginia

Contract Task Order WE29

August 2012

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic Division

Under the

NAVFAC CLEAN 1000 Program
Contract N62470-08-D-1000

Prepared by:

CH2MHILL

Virginia Beach, Virginia

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Approval Signatures

The following person(s) hereby state that they have reviewed this document and approved this document.

Approval Signatures:

8/14/12

Jim Gravette/U.S. Navy Remedial Project Manager/Date

8/14/12.

Moshood Oduwole /USEPA Remedial Project Manager/Date

8/14/12

Wade Smith/VDEQ Remedial Project Manager/Date

Document Control Numbering System: Document control is addressed in the header information in the upper-right or upper-left corner of each page. Later versions will have the version number and date on revised pages, and copies of all revised pages will be provided to the distribution list in **Worksheet #3**.

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Executive Summary

This Sampling and Analysis Plan (SAP) is being submitted to provide a systematic data collection and analysis structure for the Expanded Remedial Investigation (ERI) of Site 7 at Naval Weapons Station (WPNSTA) Yorktown, Yorktown, Virginia. In accordance with the Guidance for Uniform Federal Policy (UFP) for Quality Assurance Project Plans (QAPPs) (March 2005), this United States Navy-specific SAP includes 37 worksheets that detail various aspects of the environmental investigation process and serves as guidelines for the field work and data quality. The site-specific field standard operating procedures (SOPs) and laboratory accreditation letter are located in Appendixes A and B of this SAP (on compact disc [CD]), respectively.

The Naval Facilities Engineering Command (NAVFAC), Mid-Atlantic, is conducting this additional sampling under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). CERCLA work is being conducted with the United States Environmental Protection Agency (USEPA) Region 3 as the lead regulatory agency. The Virginia Department of Environmental Quality (VDEQ) is the state regulatory agency. Together, these three agencies form the stakeholder agencies for this project.

This document will help ensure that environmental data collected or compiled are scientifically sound, of known and documented quality, and suitable for intended uses. The laboratory information cited in this SAP is for the analytical laboratories that are currently contracted to provide analytical services for this investigation. The analytical services for this investigation will be provided by Empirical Laboratories, LLC, as the primary laboratory.

The purpose of this ERI is to further evaluate the nature and extent of CERCLA-related contamination at WPNSTA Yorktown Site 7, the Plant 3 Explosives-Contaminated Wastewater Discharge Area, due to the potential for releases in the vicinity of the former buildings associated with Explosives Loading Plant 3 (Plant 3). Although previous investigations have been conducted at Site 7, these investigations have focused on the discharge area and downgradient wetland portions of the site. The loading plant buildings have recently been demolished and the USEPA has requested that the former footprint of the buildings be investigated to determine if additional contamination is present in these areas that could impact the Discharge Area and Felgates Creek and pose potentially unacceptable risks.

This investigation will provide additional information within the footprint of the former buildings, conveyor areas, and locations of loading/unloading zones, and areas downgradient from the former building footprints, to help identify and delineate any contamination present as a result of Plant 3 operations. Data will be used to support the completion of a Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) and determine if further remedial action is required. The following is a summary of the activities that will be conducted in order to fill gaps in the current dataset and determine if additional CERCLA action is warranted:

- Forty co-located surface (0-6 inches below ground surface [bgs]) and subsurface (6-24 inches bgs) soil samples will be collected in the vicinity of the footprint of the former plant buildings, associated conveyors, and at loading/unloading zones associated with the former buildings. Samples will also be collected in areas downgradient from the former building footprints to evaluate surface runoff and soil deposition that may have occurred during plant operation or as a result of building demolition. These samples will be analyzed for VOCs, explosives, perchlorate, 3,5-dinitroaniline, and metals, which are the primary contaminants at Site 7 based on previous investigations. Samples will also be analyzed for pesticides and polychlorinated biphenyls (PCBs), which are not expected to be found, but which were requested by the regulatory agencies because they have never been analyzed at the site before.

- Seven monitoring wells will be installed throughout the site. Two monitoring wells will be installed to the east upgradient of the site, four monitoring wells will be installed downgradient of the former building footprints, and one monitoring well will be installed in the vicinity of Buildings 504 and 505 footprints.
- Four existing and seven newly installed monitoring wells will be sampled for VOCs, explosives, total and dissolved metals, perchlorate, 3,5-dinitroaniline, and natural attenuation parameters. Samples will also be analyzed for pesticides and PCBs at the request of the regulatory agencies.
- Four sediment outfall samples will be collected at the first depositional area (to be determined in the field) downgradient of the downgradient outfall locations. These samples will be analyzed for VOCs, explosives, perchlorate, 3,5-dinitroaniline, and metals, which are the primary contaminants at Site 7 based on previous investigations. Samples will also be analyzed for pesticides and PCBs at the request of the regulatory agencies.
- A minimum of eight surface water and eight sediment samples (not including the sediment outfall samples) will be collected from Felgates Creek or its tributaries, following Partnering Team review of the results of the soil, sediment outfall, and groundwater samples. The results of the soil, sediment outfall, and groundwater samples will support the number and locations of these samples.
- Up to eight pore water and eight seep (if present) samples will be collected. The pore water and seep samples will be collected and analyzed based on the results of the soil, sediment outfall, and groundwater sampling.
- Analytical data suitable for use (via data validation [DV] and data quality evaluation) will first be compared to human health and ecological risk-based screening values, as appropriate. Constituents that exceed screening values will be considered chemicals of potential concern (COPCs) for further analysis.
- Based on the nature of any screening value exceedance, an HHRA and ERA will be performed for the COPCs in order to determine if a release posing potentially unacceptable risk to human health or the environment has occurred. Human health and ecological screening will be conducted on soil, sediment outfall, and groundwater to support decisions on the placement of, and analytes for, surface water, sediment, pore water and seep (if present) samples. All analytical data collected at the site will be evaluated quantitatively in the ERA, with the exception of groundwater data, which will be evaluated qualitatively in support of the aquatic assessment.
- Concentrations found to pose potentially unacceptable risk will be compared to station-wide background 95 percent upper tolerance limits (UTLs), where such data exist. Constituents that exceed these concentrations will be considered potentially site-related unless other lines of evidence suggest otherwise.
- Data, results, and recommendations regarding the path forward for Site 7 will be documented in an ERI Report. Because there is known groundwater contamination at the site, it is anticipated that a Feasibility Study (FS), Proposed Plan (PP) and Record of Decision (ROD) will be completed following the ERI.

SAP Worksheets

Appendixes

Figures

Abbreviations and Acronyms

2-Am-DNT	2-Amino-4,6-dinitrotoluene
4-Am-DNT	4-Amino-2,6-dinitrotoluene
°C	degree Celsius
µg/kg	microgram per kilogram
µg/L	microgram per liter
µm	micrometer
µmol/g	micromole per gram
%D	percent difference or drift
%R	percent recovery
AES	atomic emission spectrometry
AM	Activity Manager
AQM	Activity Quality Manager
ASTM	American Society for Testing and Materials
AVS	acid volatile sulfide
bgs	below ground surface
BHC	benzene hexachloride
BTAG	Biological Technical Assistance Group
CA	corrective action
CAS	Chemical Abstract Service
CCC	calibration check compound
CCV	continuing calibration verification
CD	compact disc
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLEAN	Comprehensive Long-term Environmental Action—Navy
CLP	Contract Laboratory Program
COD	coefficient of determination
COPC	constituent of potential concern
CTO	Contract Task Order
CVAA	cold vapor atomic absorption
DCB	dichlorobenzene
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DL	detection limit
DNB	dinitrobenzene
DNT	dinitrotoluene
DO	dissolved oxygen
DoD	Department of Defense
DPT	direct-push technology
DQI	data quality indicator

DQO	data quality objective
DV	data validation
ECD	Electron Capture Detector
EE/CA	Engineering Evaluation/Cost Analysis
EICP	Extracted Ion Current Profile
ELAP	Environmental Laboratory Accreditation Program
ERA	Ecological Risk Assessment
ERI	Expanded Remedial Investigation
ERP	Environmental Restoration Program
ESV	Ecological Screening Value
ETSG	Ecological Technical Support Group
FID	flame ionization detector
FS	Feasibility Study
ft/day	feet per day
FTL	Field Team Leader
g	gram
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometry
GPS	global positioning system
H&S	health and safety
HCl	hydrochloric acid
HHRA	Human Health Risk Assessment
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HNO_3	nitric acid
HPLC	high performance liquid chromatography
HS&E	health, safety, and environment
HSO	Health and Safety Officer
HSP	Health and Safety Plan
IAS	Initial Assessment Study
IC	ion chromatograph
ICAL	initial calibration
ICP	inductively coupled plasma
ICS	interference check sample
ICV	initial calibration verification
ID	Identification
IDW	investigation-derived waste
ILM	Inorganic Laboratory Method
IS	internal standard
K_h	hydraulic conductivity
LC	liquid chromatography
LC/MS	liquid chromatography/mass spectrometry
LCL	lower control limit
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LIMS	Laboratory Information Management Systems

LOD	limit of detection
LODV	limit of detection verification
LOQ	limit of quantitation
LTM	long-term monitoring
MCL	Maximum Contaminant Level
MCT	matrix conductivity threshold
MDL	method detection limit
mg/kg	milligram per kilogram
mg/L	milligram per liter
mL	milliliter
mm	millimeter
MPC	Measurement Performance Criteria
MS	matrix spike
MSD	matrix spike duplicate
MSA	method of standard additions
MTBE	Methyl-tert-butyl ether
NA	not applicable
NaOH	sodium hydroxide
NAVFAC	Naval Facilities Engineering Command
NB	nitrobenzene
NC	no criteria
NIRIS	Navy Installation Restoration Information System
NJDEP	New Jersey Department of Environmental Protection
NT	nitrotoluene
NTCRA	Non-time-critical Removal Action
NTU	nephelometric turbidity unit
ORP	oxidation-reduction potential
oz	ounce
PAH	polycyclic aromatic hydrocarbon
PAL	project action limit
PC	Project Chemist
PCB	polychlorinated biphenyl
PDM	Project Data Manager
PDS	post-digestion spike
PIL	project indicator limit
PM	Project Manager
POC	point of contact
PP	Proposed Plan
PPE	personal protective equipment
PQL	project quantitation limit
PVC	polyvinyl chloride
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control

QL	quantitation limit
QSM	Quality Systems Manual
r	correlation coefficient
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
RF	response factor
RI	Remedial Investigation
ROD	Record of Decision
RPD	relative percent difference
RPM	Remedial Project Manager
RRT	relative retention time
RSD	relative standard deviation
RSL	regional screening level
RTC	response to comment
SAP	Sampling and Analysis Plan
SEM	simultaneously extractable metals
SOP	standard operating procedure
SPCC	system performance check compound
SSC	Site Safety Coordinator
SSL	soil screening level
STC	Senior Technical Consultant
SVOC	semivolatile organic compound
SWPPP	Stormwater Pollution Prevention Plan
TAL	Target Analyte List
TBD	to be determined
TCL	Target Compound List
tetryl	methyl-2,4,6-trinitrophenylnitramine
TNB	trinitrobenzene
TNT	trinitrotoluene
TOC	total organic carbon
TPH	Total Petroleum Hydrocarbon
UCL	upper control limit
UFP	Uniform Federal Policy
USEPA	United States Environmental Protection Agency
UTL	upper tolerance limit
UV-VIS	ultra violet-visible spectroscopy
VDEQ	Virginia Department of Environmental Quality
VOA	volatile organic analyte
VOC	volatile organic compound
VTSR	validated time of sample receipt
WPNSTA	Naval Weapons Station

SAP Worksheet #2—SAP Identifying Information

Site Name/Number: Site 7, Naval Weapons Station (WPNSTA) Yorktown, Yorktown, Virginia
Former Operable Unit(s): Not applicable (NA)
Contractor Name: CH2M HILL
Contract Number: N62470-08-D-1000, Contract Task Order (CTO)-WE29
Contract Title: Comprehensive Long-term Environmental Action—Navy (CLEAN) 1000

1. **This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of:**
   - *Navy Uniform Federal Policy-Sampling and Analysis Plan (UFP-SAP) Template* (Navy, 2008)
   - *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006)
   - *Uniform Federal Policy for Quality Assurance Project Plans* (USEPA, 2005)
   - *Guidance for Quality Assurance Project Plans, USEPA QA/G-5, QAMS* (USEPA, 2002)
2. **Regulatory program:**
   - Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
3. **This SAP is project-specific.**
4. **Scoping Sessions:**

Scoping Session	Date
Joint scoping session with stakeholders	6/23/10
Internal scoping session for selection of proposed sampling locations	9/15/10
Second joint scoping session with stakeholders	10/13/10
Meeting with Ecological Technical Support Group (ETSG) at Site 7	2/3/11
Scoping conference call to refine approach	2/23/11
Scoping conference call to discuss RTCs and approach	1/05/12
Joint scoping session with stakeholders	2/22/12
Joint scoping session with stakeholders	5/30/12

SAP Worksheet #2—SAP Identifying Information (continued)

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

Document*	Date	AR Number
Final Phase II Remedial Investigation Work Plan for Groundwater at Sites 1, 3, and 6 and Long-term Monitoring Work Plan for Site 7, Naval Weapons Station Yorktown, Yorktown, Virginia	CH2M HILL, 2008	002294
Final Background Study Work Plan, Naval Weapons Station Yorktown, Yorktown, Virginia and Cheatham Annex, Williamsburg, Virginia.	CH2M HILL, 2009	N00109_000008

*Copies of these listed reports may be obtained through the administrative record:
http://public.lantops-ir.org/sites/public/yorktown/Site percent20Files/AdminRecords.aspx

6. List organizational partners (stakeholders) and connection with lead organization:

- **Lead Organization**: Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic Division
- **Land Owner**: Department of Defense (DoD)
- **Lead Regulatory Agency**: United States Environmental Protection Agency (USEPA) Region 3
- **State Regulatory Agency**: Virginia Department of Environmental Quality (VDEQ)

7. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:

- All SAP elements required for this project are described herein on the 37 Uniform Federal Policy (UFP)-SAP Worksheets. Therefore, the crosswalk table is not necessary for this project.

SAP Worksheet #3—Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address	Document Control Number
Jim Gravette	Remedial Project Manager (RPM)	NAVFAC Mid-Atlantic	(757) 341-0477	james.gravette@navy.mil	An Administrative Record number will be assigned when the final document is being prepared.
Moshood Oduwole	RPM	USEPA Region 3	(215) 814-3362	oduwole.moshood@ epamail.epa.gov	
Wade Smith	RPM	VDEQ	(804) 698-4125	wade.smith@deq.virginia.gov	
John McCloskey	Biological Technical Assistance Group (BTAG)	USEPA	(804) 693-6694 x108	john_mccloskey@fws.gov	
Bonnie Capito	Librarian	NAVFAC Atlantic	(757) 322-4785	bonnie.capito@navy.mil	
Bill Friedmann	Activity Manager (AM)	CH2M HILL	(757) 671-6223	william.friedmann@ch2m.com	
Mary Anderson	Project Manager (PM)	CH2M HILL	(757) 671-6204	mary.anderson@ch2m.com	
Ward Dickens	Contractor Data Validator	CH2M HILL	(352) 384-7049	ward.dickens@ch2m.com	
Sonya Gordon	Laboratory Subcontractor PM	Empirical Laboratories, LLC	(615) 345-1115	sgordon@empirlabs.com	
Pat Beaver	Laboratory Subcontractor PM	Beaver Engineering	(615) 350-8124	data@beaverengineering.com	

SAP Worksheet #3—Distribution List (continued)

The following people may receive copies of the SAP, subsequent SAP revisions, addenda, and amendments provided by people/organizations listed above.

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address	Document Control Number
Roni Warren	Navy CLEAN Human Health Risk Assessor	CH2M HILL	(814) 364-2454	roni.warren@ch2m.com	An Administrative Record number will be assigned when the final document is being prepared.
William Kappleman	Navy CLEAN Ecological Risk Assessor	CH2M HILL	(703) 376-5152	william.kappleman@ch2m.com	
Clairette Campbell	Project Chemist (PC)	CH2M HILL	(757) 671-6335	clairette.campbell@ch2m.com	
Laura Cook	Senior Technical Consultant (STC)	CH2M HILL	(757) 671-6214	laura.cook@ch2m.com	
Doug Bitterman	Activity Quality Manager (AQM)	CH2MHILL	(757) 671-6209	doug.bitterman@ch2m.com	
Hillary Ott	Project Data Manager (PDM)	CH2M HILL	(703) 376-5165	hillary.ott@ch2m.com	
Brian Wachter	Field Team Leader (FTL)	CH2M HILL	(304) 747-3020	brian.wachter@ch2m.com	
To be determined (TBD)	Field Team Members	CH2M HILL	TBD	TBD	

SAP Worksheet #4—Project Personnel Sign-Off Sheet

The following is a list of people who are responsible for ensuring overall implementation of the SAP:

Name	Organization/ Title/Role	Telephone Number	Signature/E-mail Receipt	SAP Section Reviewed	Date SAP Read
Jim Gravette	NAVFAC Mid-Atlantic RPM	(757) 341-0477			
Moshood Oduwole	USEPA RPM	(215) 814-3362			
Wade Smith	VDEQ RPM	(804) 698-4125			
Brett Doerr	CH2M HILL SAP Quality Reviewer	(757) 671-6219			
Bill Friedmann	CH2M HILL AM	(757) 671-6223			
Anita Dodson	CH2M HILL Navy CLEAN Program Chemist	(757) 671-6218			
Laura Cook	CH2M HILL STC	(757) 671-6214			
Doug Bitterman	CH2M HILL AQM	(757) 671-6209			

The following is a list of people who may provide input and therefore review portions or all of the SAP:

Name	Organization/Title/ Role	Telephone Number	Signature/ E-mail Receipt	SAP Section Reviewed	Date SAP Read
Mary Anderson	CH2M HILL PM	(757) 671-6204			
Bonnie Capito	NAVFAC Atlantic Librarian	(757) 322-4785			
Clairette Campbell	CH2M HILL PC	(757) 671-6335			
Roni Warren	CH2M HILL Human Health Risk Assessor	(814) 364-2454			
William Kappleman	CH2M HILL Ecological Risk Assessor	(703) 376-5152			
Hillary Ott	CH2M HILL PDM	(703) 376-5165			
Brian Wachter	CH2M HILL FTL	(304) 747-3020			
Ward Dickens	CH2M HILL Data Validator	(352) 384-7049			
TBD	CH2M HILL Field Team Members	TBD			
Sonya Gordon	Empirical Laboratories PM	(615) 345-1115			
Pat Beaver	Beaver Engineering PM	(615) 350-8124			

Once this worksheet has been completed and signed it will be maintained in the project files by the PM.

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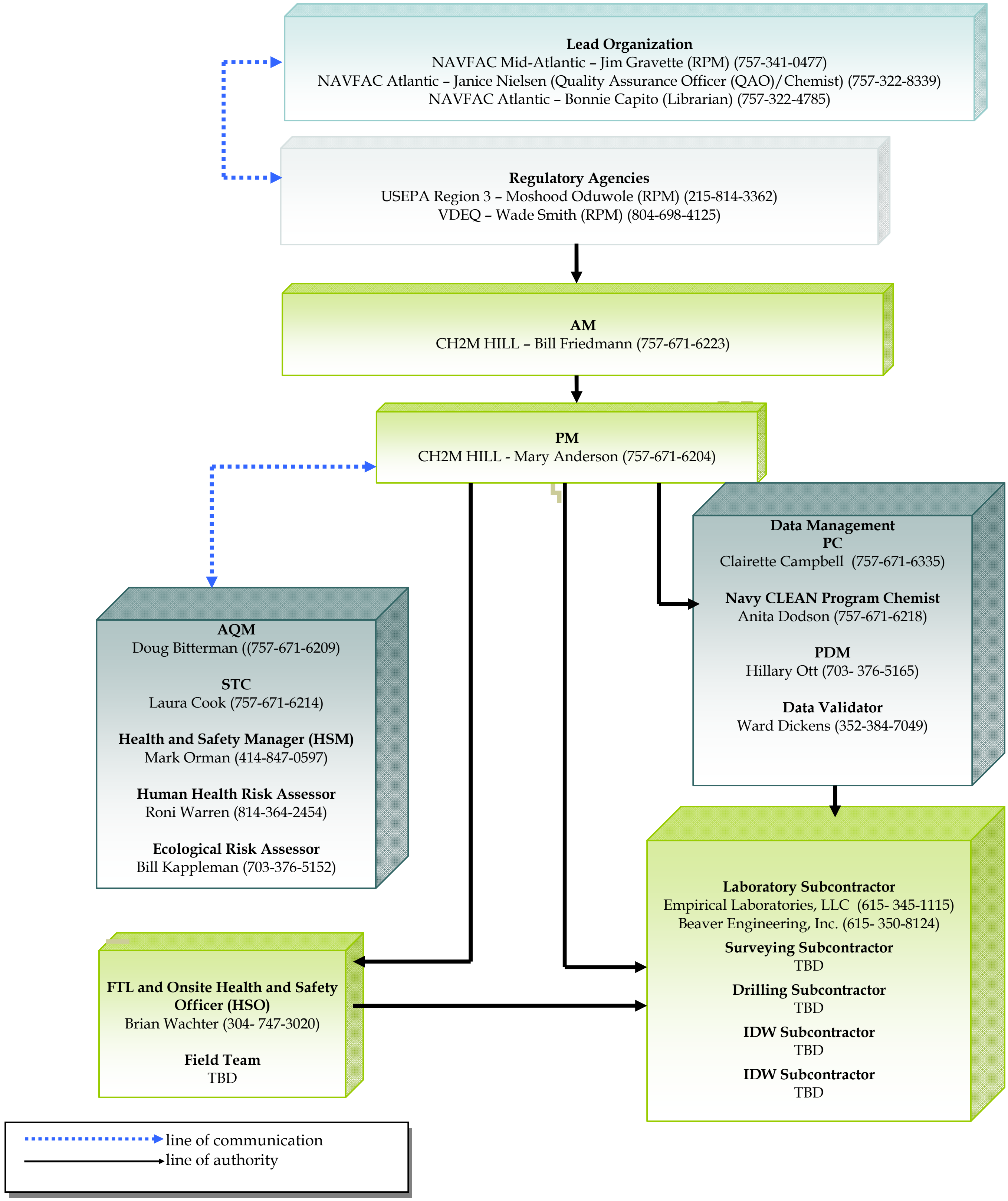
SAP Worksheet #5—Project Organizational Chart



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SAP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or e-mail	Procedure
Point of contact (POC) with USEPA Region 3 and VDEQ PMs	RPM, NAVFAC Mid-Atlantic	Jim Gravette	(757) 341-0477	All materials and information pertaining to the project will be forwarded to Moshood Oduwole and Wade Smith within 2 business days by the RPM following review.
Oversight on all projects at WPNSTA Yorktown; AM	CH2M HILL AM	Bill Friedmann	(757) 671-6223	Issues are to be reported to the RPM immediately and followed up in writing within 2 business days.
Implement SAP and manage all phases of this project	CH2M HILL PM	Mary Anderson	(757) 671-6204	Communicate directly (verbal and/or in writing) with the AM and NAVFAC as necessary.
SAP changes in the field	CH2M HILL FTL	Brian Wachter	(304) 747-3020	Communicate directly (verbal and/or in writing) with CH2M HILL AM or PM with daily meetings. Documentation of deviations from the UFP-SAP made in field logbooks; deviations made only with approval of PM, who will communicate with the AM, Navy and regulators. The FTL will ensure SAP requirements are met by field staff.
Data tracking from collection through upload to database	CH2M HILL PDM	Hillary Ott	(703) 376-5165	The PDM tracks the data and informs the PM and PC of potential problems or issues. The PM and AM are informed within 24 hours to pass on communications to Navy and regulators as appropriate.
Reporting Data Validation (DV) Issues	CH2M HILL Data Validator	Ward Dickens	(352) 384-7049	All completeness and data issues will be addressed with the laboratory. The Data Validator should copy the CH2M HILL PDM on all communications to the laboratory. The validated data package will be due within 14 calendar days of data receipt by the validator.
Reporting Analytical Laboratory Data Quality Issues	Laboratory PM	Sonya Gordon (Empirical Laboratory) Pat Beaver (Beaver Labs)	(615) 345-1115 (615) 350-8124	All quality assurance (QA)/quality control (QC) issues with project field samples will be reported by the subcontracted laboratory, who will relay them to the PDM, PC, and Contractor Quality Assurance Officer (QAO) within 2 days of discovery.
Field and Analytical Corrective Actions (CAs)	CH2M HILL Program Chemist PC FTL	Anita Dodson Clairette Campbell Brian Wachter	(757) 671-6218 (757) 671-6335 (304) 747-3020	The need for CA for field and analytical issues will be determined by the FTL, PC, senior support staff, and/or Contractor QAO as necessary. The Sr. support will ensure Quality Assurance Project Plan (QAPP) requirements are met by field staff. The PC will ensure QAPP requirements are met by the laboratory. The FTL will notify the PM of any needed field CAs. The PM will have 24 hours to respond to the request for field CA. CA with laboratories will be coordinated by PC. The PC will notify the Program Chemist, who will in turn notify the Navy Chemist of any lab issues that render data quality objectives (DQOs) unattainable or cause delivery issues such that project schedule cannot be met.

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SAP Worksheet #7—Personnel Responsibilities and Qualifications Table

Name	Organization/Title	Responsibilities	Qualifications	
			Education	**Years of Applicable Experience**
Jim Gravette	NAVFAC Mid-Atlantic RPM	Coordinates all environmental activities at WPNSTA Yorktown.	1992 BS Geological Sciences 1997 Geology MS	16
Moshood Oduwole	USEPA Region 3 RPM	Manages all aspects of project to confirm Federal regulations and requirements are met.	2002 BS Geology 2009 MS Environmental Geology	5
Wade Smith	VDEQ RPM	Manages all aspects of project to confirm State regulations and requirements are met.	1995 BS Earth Science 1998 MS Environmental Engineering	12
Bonnie Capito	NAVFAC Mid-Atlantic Librarian	Responsible for document tracking and filing.	MSLS Library and Information Science	30
Bill Friedmann, P.G.	CH2M HILL AM	Responsible for support to Navy to implement CERCLA Environmental Restoration Program (ERP) at WPNSTA Yorktown	1989 BS Geology	21
Mary Anderson	CH2M HILL PM	Day-to-day project management to implement SAP. Directs and oversees staff; health, safety, and environment (HS&E). Contractor POC for decision-making. Conducts data usability assessment.	1992 BS Biology 1994 MS Biology	17
Douglas Bitterman, P.G.	CH2M HILL AQM	Provides activity level review	1985 BS Geology 1989 MS Civil Engineering	22
Laura Cook, P.G.	CH2M HILL STC	Provides senior technical oversight.	1998 BS Geological and Environmental Sciences	12
William Kappleman	CH2M HILL Senior Ecological Risk Assessor	Conducts Ecological Risk Assessment (ERA) to determine any impacts to ecological receptors	1983 BS Wildlife Biology 1991 MS Wildlife Biology	23

SAP Worksheet #7—Personnel Responsibilities and Qualifications Table (continued)

Name	Organization/Title	Responsibilities	Qualifications	
			Education	**Years of Applicable Experience**
Roni Warren, P.E.	CH2M HILL Human Health Risk Assessor	Responsible for performing Human Health Risk Assessment (HHRA)	1988 BS Computer Science 1990 MS Environmental Engineering	20
Anita Dodson	CH2M HILL Program Chemist	Provides program level review of the UFP-SAP	1994 BS Chemistry	17
Clairette Campbell	CH2M HILL PC	Performs oversight of laboratory and data validators, and evaluates usability of data	2008 BS Chemistry	5
Brian Wachter	CH2M HILL FTL	Supervises field sampling and coordinates all field activities	2006 BS Geology	6
Ward Dickens	CH2M HILL Data Validator	Responsible for the analytical data review and validation	1978 BS Chemistry/ Biology/Mathematics 1984 MS Analytical Chemistry	29
Hillary Ott	CH2M HILL PDM	Manages sample tracking, coordinates with laboratory and data-validator, data management	2009 BS Environmental Geological Sciences	3
Mark Orman, CSP, CHMM, ARM	CH2M HILL Health and Safety Officer (HSO)	Oversees health and safety (H&S) for CLEAN Program	1992 BS Environmental Science	16
Sonya Gordon	Empirical Laboratories PM	Provides analytical services for Empirical Laboratories, LLC	BA Chemistry 1994	16
Pat Beaver	Beaver Engineering PM	Provides analytical services for Beaver Engineering, Inc.	TBD	TBD
TBD	Drilling Subcontractor	TBD	TBD	TBD

SAP Worksheet #8—Special Personnel Training Requirements Table

Project Function	Specialized Training By Title or Description of Course	Training Provider	Training Date	Personnel /Groups Receiving Training	Personnel Titles / Organizational Affiliation	Location of Training Records / Certificates
All site activities	Recognize, Retreat and Respond (3 "R") Training for explosives	Munitions Response Personnel	Personnel files	FTL, field team members, and Site Safety Coordinator (SSC)	FTL, SSC, and field team members from CH2M HILL	CH2M HILL, NAVFAC, regulatory agency, or subcontractor Human Resources Department

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SAP Worksheet #9—Project Scoping Session Participants Sheet Summary

Project Name: Yorktown Site 7 Expanded Remedial Investigation (ERI) **Projected Date(s) of Sampling:** Fall 2012 **PM:** Adam Forshey (at the time of the scoping sessions)				**Site Name:** Site 7 **Site Location:** WPNSTA Yorktown, Virginia		
Date of Sessions: June 2010, September 2010, October 2010 and February 2011 **Scoping Session Purpose:** WPNSTA Partnering Team and internal meetings to discuss the Site 7 ERI						
Name	**Title**	**Affiliation**	**Date[1]**	**Phone #**	**E-mail Address**	**Project Role**
Bill Friedmann	AM	CH2M HILL	All meetings	757-671-6223	william.friedmann@ch2m.com	Overseeing project delivery, technical support
Adam Forshey	PM	CH2M HILL	All Meetings	757-671-6267	adam.forshey@ch2m.com	UFP-SAP production, project management
Rob Thomson	RPM	USEPA	6/10, 10/10, 2/11	215-814-3357	thomson.bob@epamail.epa.gov	Lead representative of USEPA, responsible for review of documents and ensure that appropriate regulations are applied
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[1] Date refers to the date of the meetings each individual participated in

SAP Worksheet #9—Project Scoping Session Participants Sheet Summary (continued)

Summary of Scoping Sessions and Outcomes

Four scoping sessions were held in support of developing the approach for the ERI to be completed at Site 7, WPNSTA Yorktown. Partnering minutes, detailing each scoping session are provided in **Appendix C**. Summaries of each session are provided below.

June 2010

The first of these scoping sessions was held on June 23, 2010 and provided the team with the previous data from the site to determine what additional sampling was necessary. The team discussed the site history and the recent demolition of all existing buildings at Site 7. Rob Thomson (USEPA) requested that the former footprints of the recently demolished buildings be investigated because these areas were not previously evaluated and may be potential sources of contamination at the site. Rob also requested that construction drawings be obtained and considered when placing sample locations. Tom Kowalski (Navy) agreed to look for a demolition report for the site and CH2M HILL agreed to research construction drawings. A tentative sampling plan involving direct-push technology (DPT) samples and installation of new monitoring wells was discussed. Wade Smith (VDEQ) requested that a well be installed in the vicinity of Building 505.

September 2010

The September 2010 scoping session was an internal session held by CH2M HILL employees to develop a sampling approach for Site 7 in consideration of team recommendations made during the June 2010 partnering meeting. It was noted that the system of berms at the site was still in place, even though the buildings had been demolished. The team proposed a grid-based sampling strategy for soil and groundwater along the former locations of the building and conveyors, with 24-hour turnaround time on the initial samples and additional locations selected based on the results of the primary samples. Monitoring wells were proposed along the eastern perimeter of the site, in the vicinity of Buildings 504 and 505, and in the vicinity of the conveyors and buildings (based on the DPT results). A similar grid approach was discussed for surface water and sediment sampling. The CH2M HILL team also discussed possible analytical parameters and agreed that all media would be sampled for Target Compound List (TCL) volatile organic compounds (VOCs), explosives, and Target Analyte List (TAL) metals and cyanide. Groundwater would also be analyzed for dissolved TAL metals and perchlorate. Semivolatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs) were not proposed for analysis based on previous analysis of SVOCs and no historical use of pesticides and PCBs.

October 2010

On October 13, 2010, the WPNSTA Yorktown Partnering Team discussed research completed since the June Partnering meeting, including determination of former building functions and designs. The sampling approach discussed during the internal CH2M HILL scoping session was adopted with a few additional requirements.

The team agreed to hold an onsite meeting with the ETSG staff to ensure the approach to evaluate ecological concerns was adequate for all stakeholder agencies. Rob indicated that if PCBs and pesticides had not previously been analyzed, they would be required because full suite analysis is required for all CERCLA sites. The team agreed that no SVOC analysis was necessary because, with the exception of likely lab contaminants, only one polycyclic aromatic hydrocarbon (PAH) was detected prior to the pilot study previously completed at the site and that sample location was remediated.

SAP Worksheet #9—Project Scoping Session Participants Sheet Summary (continued)

February 3, 2011 Site Visit

In order to identify optimal locations to address ecological concerns, the Yorktown Tier I Partnering team and technical support staff from ESTG walked the site, focusing on the southern site boundary with Felgates Creek in the eastern, central, and west-central areas of the site. A number of potential drainage pathways (eroded channels within the bank) were noted, as were several possible seeps (wet but not obviously flowing). Several residual structures were also observed:

- A drainage pipe in a retaining wall south of the location of former Building 2008
- A collapsed drainage pipe leading to a defined drainage channel in the west-central portion of the site
- A number of sewer covers approximately along the line of the former conveyor structure
- A possible sump-like structure near the location of structure 1904 on the site map

Following the site walk, a brief discussion occurred. It was recommended that:

- The entire southern end of the site be observed in detail to map out potential drainage pathways (including residual piping) and seep locations. This should occur in March or April, depending upon rainfall, when seeps are most likely to be flowing.
- The sewer utility line and the sump-like structure should be investigated to determine if they pose a possible transport pathway and/or a source of residual contamination.
- Groundwater and soil sampling should proceed as originally scoped.

The team agreed that once groundwater data (from permanent monitoring wells, not just DPT), soil data, and the results of the site reconnaissance are available, this information should be used to select sample locations for seeps and pore water. Results of soil, groundwater, pore water, and seeps data will be used to determine likely contaminant transport pathways and determine the locations of surface water and sediment samples, if determined to be necessary. Surface water, sediment, seep, and (if warranted) pore water samples would be collected in spring 2012 during the time period when seeps are most likely to flow if the results of the soil and groundwater investigations warrant.

February 23, 2011 Follow-up Conference Call

Bill Friedmann, Adam Forshey, Rob Thomson, Wade Smith, and Tom Kowalski held a conference call on February 23, 2011 to discuss how to focus the initial and contingency soil and groundwater sampling approach to reduce cost, in response to the action items created following the February 3, 2011 site visit.

Following a detailed review of data, it was determined that perchlorates and 3,5-dinitroaniline were also potential contaminants at Site 7 and should be evaluated as part of the ERI. Due to the addition of these chemicals, the initial primary and secondary grid approach with quick turn-around sampling was excessively expensive and the team wanted to discuss other more affordable potential sampling approaches that would not compromise the quality of the investigation. The team agreed that surface and subsurface soil only would be collected at the initial sample locations in the vicinity of the buildings where explosives were handled and stored at the site. These samples would be analyzed for VOCs, explosives, pesticides/PCBs, metals, 3,5-dinitroaniline and perchlorate. Following receipt of the sample data, the team would screen data against background concentrations, ecological screening values (ESVs) and regional screening levels (RSLs) and select up to ten additional contingency locations for soil sampling in addition to three monitoring well locations. Rob suggested that three tentative monitoring well locations be selected in this area in the event that there were no notable concentrations of contaminants in soil. The rationale for this is due to the possibility that contaminants have migrated into groundwater and are no longer present in soil. The original approach of soil sampling between Buildings 504 and 505 and installation of upgradient wells was not modified.

SAP Worksheet #9—Project Scoping Session Participants Sheet Summary (continued)

January 5, 2012 Conference Call

VDEQ provided comments on the draft SAP on October 19, 2011. USEPA responded with comments on the draft SAP on December 12, 2011 (Round 1 comments). Bill Friedmann, Adam Forshey, Jim Gravette, Wade Smith, and Moshood Oduwole held a technical conference call on January 5, 2012 to review and discuss the response to comments (RTCs). At the start of the conference call the group reviewed the different processes that were performed in each of the former buildings within Site 7, and noted that Building 502 was the only building that contained floor drains. In order to clarify the site characteristics it was requested that the red dashed line on appropriate figures be extended continuously from Building 502 to Building 375. Prior to discussing the comments on the draft, it was noted that the initial sampling plan was recommended during the site visit with BTAG and the ETSG on February 3, 2011.

During the conference call, the group discussed the comments on the Draft UFP-SAP that addressed the following issues:

- Limitations of the sampling approach, specifically not enough samples
- Whether a phased approach was appropriate, specifically for groundwater and seep samples
- The contaminant analysis proposed and whether analyzing for SVOCs (particularly PAHs) was necessary
- The possibility of recontamination of the previously remediated drainage area
- Using soil screening levels (SSLs) to determine if leaching to groundwater was an issue

The following solutions were proposed in response to the comments and concerns discussed:

- Collect discrete soil samples and provide a summary table in the SAP detailing why sample locations were selected
- Collect the samples in a phased approach, with groundwater and soil samples collected first, and if seep samples are determined to be necessary collect an additional round of groundwater samples at the same time as the seep, surface water, and sediment samples
- SVOCs would not be sampled for based on the Partnering Teams previous agreement, which would be documented in the SAP
- Review previous investigation data and add the footprint of the previous remediated area to the proposed sampling locations to determine if recontamination occurred
- Use of SSLs to determine if leaching from soil to groundwater is occurring at concentrations which pose a potential risk

A review of the schedule and path forward at the end of the conference call resulted in a suggestion to expedite the RTCs to the regulators and to coordinate regulator technical support so that the RTCs could be discussed during the February Partnering Team meeting.

February 2012

Following the January 5, 2012 conference call, RTCs (Round 1) were submitted February 9, 2012 to the Team (**Appendix C**). The February 2012 Partnering Team meeting was held on February 22 and 23, 2012. At this time, USEPA was still evaluating and drafting additional comments to the RTCs. The overall purpose of the discussion was to look over the major comments and concerns from USEPA/BTAG.

The Team discussed specific Round 1 comments from the USEPA. The first comment discussed was a concern about the approach to collect surface water, sediment, pore water, and seep samples.

SAP Worksheet #9—Project Scoping Session Participants Sheet Summary (continued)

In the draft SAP, these samples were dependent on the outcome of the first round of groundwater samples. It was discussed that in the original Remedial Investigation (RI) there were samples from Felgates Creek and there were a number of discharges/seep locations from the hillside leading to the wetland area identified during a Summer 2011 site walk. It was argued that this was a potential contaminant transport via the drainage outfalls, and that correct timing of the seep/sediment sampling would be needed at the same time to determine what has been released historically. It was determined that the SAP needed to be revised to indicate that surface water and sediment sampling would no longer be conditional, and would be collected regardless of the outcome of the soil and groundwater samples. These samples will be collected from downstream of the pipes near a depositional area. The seep samples however, would still be collected based on the soil and groundwater results. It was proposed that pipes/drainages and outfalls be included in the SAP, and to include a sediment and surface water sampling map.

Another major concern discussed was that the information presented in the SAP was not sufficient for determining sample locations, that additional information needed to be placed in the text, and that the overall number of samples was not adequate. In order to appropriately evaluate the site, it was determined that a review of all of the historical documents needed to be performed in support of the proposed sample locations, and all of the historical documents would be posted for review.

Additional comments were discussed and the following actions were agreed upon:

- Need to specifically document in the SAP the reasoning for not looking at PAHs
- The document decision making process needs to be clarified
- Cleanup goals from the Record of Decision (ROD) need to be included in a future UFP-SAP
- Need more sampling in the excavated area to assess risk

May 2012

The second round (Round 2) of comments from the USEPA on the draft report were submitted April 4, 2012 to the team. The Navy responded and sent the Round 2 RTCs to the team on May 14, 2012 (**Appendix C**). The May 2012 Partnering Team meeting was held on May 30 and 31, 2012. The meeting started with a quick review of technical support background and information for Site 7, followed by showing the most recent sampling approach proposal developed during the Round 2 RTCs.

The Team began to discuss the current proposed sample locations and where additional samples may be warranted. Throughout the discussion of all of the different buildings formerly located within Site 7, it was proposed that samples would be collected within former building footprints, in likely loading/unloading areas, and along the former conveyor areas. In addition, the sediment samples collected from outfall locations will be collected from the first depositional area, not from right at the outfall where the scour zone is located. As a follow up action, it was agreed that CH2M HILL would look into the building drawings and historical documents to determine the source of the discharge line from Building 375.

Based on the discussions during the May 2012 Partnering Team meeting an additional third round of comments (Round 3) from the USEPA were provided in a letter on June 6, 2012. The Navy responded and replied with Round 3 RTCs on June 13, 2012, which outlined the final sampling approach detailed in this UFP-SAP. The USEPA accepted the Round 3 RTCs on June 19, 2012, and the team was able to move forward with the outlined sampling approach. Round 1, 2, and 3 comments and RTCs are provided in **Appendix C**.

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SAP Worksheet #10—Problem Definition

The purpose of this ERI is to further evaluate the nature and extent of CERCLA-related contamination at WPNSTA Yorktown Site 7, due to the potential for releases in the vicinity of the former buildings associated with Explosives Loading Plant 3 (Plant 3). Although previous investigations have been conducted at Site 7, these investigations have focused on the discharge area and the wetland area downstream of the discharge. The loading plant buildings have recently been demolished and the USEPA has requested that the former footprint of the buildings be investigated to determine if additional contamination is present in these areas that could impact the adjacent wetland and Felgates Creek and pose potentially unacceptable risks.

This investigation will be conducted in a phased approach with two sampling events, and will provide additional information within the footprint of the former buildings, conveyor areas, and locations of loading/unloading zones, and areas downgradient from the former buildings, to help identify and delineate any contamination present as a result of Plant 3 operations. The investigation will also provide new data for the down-gradient wetland area in locations not previously sampled Additional soil, sediment outfall, groundwater, surface water, sediment, and potentially pore water and seep sampling is proposed to determine the nature and extent of any potential releases and evaluate if potential unacceptable human health and/or ecological risks exists at Site 7. Data will be used to support the completion of an HHRA and ERA and determine if further investigation or remedial action is required.

WPNSTA Yorktown History and Location

WPNSTA Yorktown is a 10,624-acre installation located on the Virginia Peninsula in York and James City Counties Virginia (**Figure 1**). WPNSTA Yorktown is bounded to the northwest by Cheatham Annex to the northeast by the York River and the Colonial National Historic Parkway, to the southwest by Route 143 and Interstate 64, and to the southeast by Route 238 and the town of Lackey.

Originally named the United States Mine Depot, WPNSTA Yorktown was established in 1918 to support the laying of mines in the North Sea during World War I. For 20 years after World War I, the depot continued to receive, reclaim, store, and issue mines, depth charges, and related materials. During World War II, the facility was expanded to include three trinitrotoluene (TNT) loading plants and new torpedo overhaul facilities. A research and development laboratory for experimentation with high explosives was established in 1944. In 1947, a quality evaluation laboratory was developed to monitor special tasks assigned to the facility which included the design and development of depth charges and advanced underwater weapons. On August 7, 1959, the depot was renamed the United States WPNSTA. Today, the primary mission of WPNSTA Yorktown is to provide ordnance, technical support, and related services to sustain the war-fighting capability of the armed forces in support of national military strategy.

Site 7 History and Location

Site 7 is located in the northern portion of WPNSTA Yorktown (**Figure 1**). The site is surrounded by dense tree cover, bordered to the north by Poe Road, and bordered to the south by an unnamed tributary approximately 1 mile upstream from the confluence of Felgates Creek and the York River. At present, all buildings at the former Site 7 have been demolished; however, the earthen berms

SAP Worksheet #10—Problem Definition (continued)

adjacent to the former buildings remain in place, resulting in uneven, and in places, steep terrain ranging from 20- to 50-feet above mean sea level across the site. The area downgradient of the former buildings is relatively flat with the exception of the drainage area, which consists of a ravine with relatively steep slopes. Groundwater flow at the site is generally to the south and south-west towards Felgates Creek (**Figure 2**).

Research completed following the first scoping session to support this SAP indicated that Plant 3 began operations between October 1942 and March 1943 with the construction of Building 375 (Mixing Facility), known then as the Torpex Plant. In 1944, ten barricaded pits were installed in the rear of the facility to allow the vertical loading of British “Tall Boys.” Further renovations and additions were made from September 1944 to August 1945, which included the construction of Buildings 502 (Prep Warehouse), 502A (Conveyor), 503 (Shell Processing), 503A (Conveyor), 504 (TNT Storage), 505 (Powdered Metal Storage) and 505A (Conveyor). From 1955 to 1965, Building 503 was renovated and modernized to load methyl-2,4,6-trinitrophenylnitramine (tetryl) pellets and guided missile warheads. Beginning in 1977, plans to convert Plant 3 into a plastic-bonded explosive production processing facility were initiated. To facilitate this change, many of the buildings underwent extensive modifications. Building 375 received a new 300-gallon mixer, vacuum system, heptane recovery system, monorail and hoist, water heater, fume and dust exhaust system, remote cameras, and water wash air tumbler system; Building 502 received a monorail and hoist and a ventilation system and mixing equipment; Building 503 received two walk-in curing rooms, overhead monorail system with a lift section for thermal coating and painting, and a water wash paint booth with exhaust; and Building 505A received a conveyor.

Buildings 2007 and 2008 were also present in the vicinity of Plant 3 during operation. These structures were used for storage purposes. The internet Navy Facilities Assets Data Store records identify these buildings as hazard/flammable storage buildings built in 1991. An inspection of Building 2007 conducted in January 2006 in support of the Other Environmental Liabilities database identified 55-gallon drums of isopropyl alcohol in secondary containment lined with a chemical resistant polypropylene liner. No storage of chemicals was present in Building 2008 during the inspection. Production at Plant 3 continued until approximately 1986; all associated buildings were decommissioned and demolished in 2009.

Site 7 was initially identified during the 1984 Initial Assessment Study (IAS) for WPNSTA Yorktown (Versar, Inc.) as the 300-foot-long drainage area downgradient of Building 375 (see “Site Boundary” in) **Figure 2**. The IAS indicated the drainage area received untreated explosives-contaminated wastewater which was directed through a flume until 1973, when a water treatment system was installed to treat effluent prior to discharge. After 1986, the treated wastewater was redirected to the sanitary sewer system and ultimately to Hampton Roads Sanitation District. Following the IAS, numerous investigations and reports have been completed in support of the site management process at Site 7 including:

- Interim RI Report (Versar Inc., 1991)
- Round One RI Report (Baker and Weston, 1993)
- Round Two RI Report (Baker, 1998a)
- Soil Characterization Study (Baker, 1998b)
- Field Scale Pilot Study (Baker, 1997)

SAP Worksheet #10—Problem Definition (continued)

- Feasibility Study (FS) for Sites 6 and 7 (Baker, 1998c)
- ROD (USEPA, 1998)
- Long-term Monitoring (LTM) Report for Sites 1, 3, and 7 (Baker, 2006a)
- Phase I RI for Groundwater at Operable Unit I (Baker, 2006b)
- LTM Report, Site 7 (CH2M HILL, 2010)

Sample locations from previous investigations are shown on **Figure 3**. Historical sampling data is used in this investigation to support the proposed sampling approach, but will not be used as part of the risk evaluation.

The drainage area was identified as having the highest levels of contamination at Site 7 due to elevated concentrations of explosives in soil and sediment (Baker 1998a). Explosives and VOCs were also detected in groundwater and surface water at concentrations greater than corresponding screening criteria. SVOCs were detected, but were attributed to laboratory contamination (Baker, 1998a). Metals were also detected in sediment at levels posing potentially unacceptable risk to ecological receptors.

A Pilot Study was conducted to delineate the extent of explosives contamination within the Site 7 boundary and to excavate contaminated soils and sediment for treatment (Baker, 1997). Following the completion of the Pilot Study removal action and offsite treatment, a ROD was signed in 1998 affirming that soil and sediment within the drainage area had been remediated to levels protective of future industrial land use, but indicating that an additional remedy would be necessary for groundwater at the site (USEPA, 1998). Additionally, the ROD stated that upon completion of the Pilot Study removal action, which had already been conducted, no additional action was necessary for ecological receptors as soils, surface water, and sediment within the drainage area no longer posed an ecological risk.

LTM was conducted annually from 2000 to 2009 following the removal action to evaluate groundwater concentrations and ensure that sediment and surface water concentrations remained below screening values (Baker, 2006a; CH2M HILL, 2010). LTM results indicated that explosives and VOCs were still present in groundwater. The LTM sampling event in 2005 included sampling of sediment and surface water and results showed that no VOCs or explosives were detected and metal concentrations were comparable to non-impacted sediments.

In 2004, a Phase I RI for Groundwater (CH2M HILL, 2004) was completed. The report noted that concentrations of contaminants in groundwater had decreased following the removal action and recommended continued LTM of groundwater and installation of an additional well at the discharge point at the site. During the review of the 2009 LTM monitoring data, the WPNSTA Yorktown Partnering Team noted that concentrations of explosives in the new well located in the vicinity of the discharge were notably higher than in the existing wells, which are all located upgradient of the discharge. The team also noted that the buildings at the site had been demolished and discussed the potential for an ongoing source of contamination to the discharge area from beneath the former footprints of the buildings. In order to evaluate the potential for a continuing source to groundwater, the team determined that an ERI was necessary for all buildings which make up the Plant 3 area (**Figure 2**). Because the team agreed to additional investigation, it was also

SAP Worksheet #10—Problem Definition (continued)

recommended that LTM be discontinued at the site. In July 2012, the Navy, USEPA and VDEQ agreed to suspend LTM for groundwater until the completion of the ERI investigation.

Historical building use was reviewed and it was determined that the area between and downgradient of former Buildings 502 and 503 would require additional evaluation in addition to the area in the vicinity of Buildings 504 and 505 because these buildings were used for shell processing, processing preparation, metals storage and TNT storage. The team noted that sediment and surface water samples were not previously collected downgradient of these buildings and determined that sampling would likely be necessary to evaluate contaminant fate and transport.

The 1998 ROD (USEPA, 1998) states that no additional action would be necessary for either human health or ecological receptors following completion of the Pilot Study removal action other than land use controls, and both the 2002 and 2007 Five-Year Reviews (Baker, 2002 and CH2M HILL, 2007), document that the remedy for soil and sediment is protective of human health and the environment. However, following the expansion of the site boundary to include all Plant 3 structures, additional soil samples are proposed in this investigation to evaluate current site conditions, determine the nature and extent of any potential releases from surface runoff and building demolition activities, and evaluate potential site risks. Additional soil, sediment outfall, groundwater, surface water, sediment, and potentially pore water and seep sampling is proposed in this investigation to determine the nature and extent of any potential releases and if potential unacceptable human health and/or ecological risks exist at Site 7.

Hydrogeological Setting

WPNSTA Yorktown

WPNSTA Yorktown is situated within the Virginia Coastal Plain Physiographic Province, which is characterized by unconsolidated sediments several thousand feet in thickness (Meng and Harsh, 1988). Deposition and erosion associated with fluctuating sea levels resulted in terraces that decrease in topographic elevation in a stair-step pattern with scarps, oriented north to south, that delineate the eroded shoreline along the toe of each terrace. Two terraces (Lackey Plain and Croaker Flat) are divided by one scarp (the Camp Peary Scarp) within the boundaries of WPNSTA Yorktown.

Site-specific

Site 7 is located within the Croaker Flat Terrace portion of WPNSTA Yorktown. Surficial geology generally consists of a fine-grained gray clay unit lithologically consistent with the Yorktown confining unit. This unit is between 1 and 13 feet thick at the site and is underlain by the Yorktown-Eastover aquifer, which is believed to be between 80 and 100 feet thick in this area. The Yorktown-Eastover aquifer is composed of gray-blue and gray-green fine- to coarse-grained sand mixed with shell hash.

The horizontal hydraulic conductivity (K_h) values calculated based on the results of aquifer testing at Site 7 ranged from 0.43 foot per day (ft/day) to 3.4 ft/day. Depth to groundwater at the site ranges from 20 to 33 feet below ground surface (bgs) across the majority of the site. The Yorktown-Eastover aquifer groundwater discharges to Felgates Creek located west/southwest of the site, based upon measured groundwater elevations.

SAP Worksheet #10—Problem Definition (continued)

A seep survey conducted in May 2011 involving a member of BTAG and staff geologist from CH2M HILL identified many possible groundwater seep locations, particularly in the area southeast of the site along the creek. Seep locations were recorded with a global positioning system (GPS) during the survey and will be used to support the potential collection points for groundwater seeps, should it be necessary.

Problem Definition

Previous investigations at Site 7 identified concentrations of VOCs, explosives, perchlorate and metals as potential site-related contaminants (Baker, 1998a). SVOCs were analyzed previously and were determined not to be site-related contaminants (Baker, 1998a). Pesticides and PCBs have never been analyzed at Site 7. Soil and sediment in the drainage area have been excavated, but contamination remains in groundwater at levels greater than corresponding screening values. Buildings comprising of Plant 3 were demolished in 2009. In order to evaluate the potential for a continuing source from the former building footprint areas to groundwater and to evaluate the potential for downgradient migration of contamination from the building footprint areas, conveyor areas, and loading/unloading zones, additional soil, sediment outfall, groundwater, surface water and sediment sampling is necessary.

Environmental Questions answered by this Project

Is there contamination present in the vicinity of the former building footprints and/or migration pathways between the former buildings and downgradient media at levels posing potentially unacceptable risks, and if contamination is present, can contaminants be degraded through natural attenuation?

The following activities will be completed in part to answer this environmental question:

- Forty surface soil and subsurface soil samples will be collected in the vicinity of the former Plant 3 buildings, the conveyors connecting the buildings, the most likely loading/unloading zones, and areas upgradient and downgradient from the buildings (**Figure 4**). Surface soil samples will be collected from 0- to 6-inches bgs, while subsurface soil samples will be collected from 6- to 24-inches bgs. Samples will be collected with a hand auger and will be submitted for offsite laboratory analysis of VOCs, explosives, metals, 3,5-dinitroaniline, perchlorate, pesticides and PCBs, pH, and total organic carbon (TOC).
- Seven monitoring wells will be installed throughout the site:
    - Two monitoring wells will be installed to the east of the site to evaluate upgradient/ background conditions.
    - One monitoring well will be installed in the vicinity of Buildings 504 and 505 to evaluate groundwater in this area.
    - Four monitoring wells will be installed downgradient of the former building footprints.
- Samples will be collected from the seven newly installed monitoring wells and four of the existing monitoring wells and will be analyzed for VOCs, explosives, total and dissolved metals, 3,5-dinitroaniline, perchlorate, pesticides, PCBs, chloride, nitrate, nitrite, sulfate, sulfide, pH, TOC, alkalinity, ferrous iron and methane. Existing well 7GW04 will not be sampled because it is not in the vicinity of the site and does not truly represent upgradient conditions due to its location.

SAP Worksheet #10—Problem Definition (continued)

- Four sediment outfall samples will be collected at the first depositional area (to be determined in the field) downgradient from each of the downgradient outfall locations. These samples will be analyzed for VOCs, explosives, perchlorate, 3,5-dinitroaniline, and metals, which are the primary contaminants at Site 7 based on previous investigations. Samples will also be analyzed for pesticides and PCBs at the request of the regulatory agencies, as well as pH and TOC. Outfall location identified as NR-017 will not be sampled, as there are no drainage features that connect Site 7 to this drainage feature.
- A minimum of eight co-located surface water and sediment samples will be collected from Felgates Creek or its tributaries based on results of soil, sediment outfall, and groundwater sampling, in locations not previously evaluated. Analytes will be determined using a multiple lines of evidence approach including presence of contaminants in soil, sediment outfall, and groundwater that could migrate to surface water and sediment. The locations of the surface water and sediment samples will be determined by the team with input from the ecological technical support.
- Up to eight pore water and eight seep samples will be collected if results of the groundwater samples indicate a potential risk to ecological receptors. The location of the pore water and seep samples will be based on the site seep survey (**Worksheet #9**) and results of groundwater sampling. The list of analytes will be determined based on contaminants which exceeded background and human health and/or ESVs in groundwater. In addition, if the pore water and seep samples are determined to be necessary, an additional round of groundwater samples will be collected.

Do site contaminant concentrations pose a potentially unacceptable human health or ecological risk?

Surface/subsurface soil, sediment outfall, groundwater, surface water, and sediment sample analytical data collected during investigation activities will be compared to human health and ecological risk-based screening values outlined in **Worksheet #11** and detailed **in Worksheets #15-1** through **15-12**. Historical data will not be used because this investigation is intended to evaluate contamination from the former building areas rather than the drainage, which was remediated previously. Chemicals detected at concentrations exceeding human health and ESVs will be constituents of potential concern (COPCs) for further evaluation as part of an HHRA and/or ERA. Concentrations found to pose potentially unacceptable risk in the risk assessments will then be compared to background concentrations to determine if the contamination is site-related. The results of the HHRA, ERA, and background comparison will be used to determine if contamination in the vicinity of the buildings at the site poses potentially unacceptable risk to human health or the environment.

Is remedial action or further investigation (i.e., further data collection and evaluation) warranted at the site based on the results of this study?

If it is determined that unacceptable risks are present in the vicinity of the former building footprints upgradient of Site 7, appropriate action will be evaluated in a FS or Engineering Evaluation/Cost Analysis (EE/CA).

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements

Who will use the data?

The data will be used by the Navy, its contractors, and the other stakeholder agencies to determine if contamination is present in the vicinity of the former building footprints and associated conveyor locations upgradient of the Site 7 drainage area, to assess potential risks to human health and the environment and to evaluate whether additional sampling and/or action is necessary. If appropriate, the information will be used to evaluate actions to be taken to provide adequate protection of human health and the environment. Engineers and scientists will evaluate the data for decision making and a chemist will evaluate laboratory data quality. Once published in the Administrative Record, the data will be available to the public.

What types of data are needed?

Analytical data for site soil, sediment, surface water, and groundwater are required for this project. Pore water, and seep data may also be necessary if soil and groundwater results indicate likely migration of contaminants into adjacent surface water bodies at levels that may pose unacceptable risk to human or ecological receptors. Initial soil, sediment outfall, and groundwater samples will be analyzed for VOCs, explosives, pesticides, PCBs, perchlorate, 3,5-dinitroaniline and metals (total and dissolved for groundwater). In accordance with USEPA Region III, *Guidance on the Selection of Metal Results from Monitoring Well Samples for Use in the Quantitative Assessment of Risk* (1992), filtered metals data are used when a review of the data shows that filtered results are dissimilar to the unfiltered samples. Groundwater samples will also be analyzed for these constituents in addition to chloride, nitrate, nitrite, sulfate, sulfide, TOC, alkalinity, ferrous iron, and methane to evaluate the potential for natural attenuation at the site. In addition, during groundwater sampling, water quality parameters (i.e., dissolved oxygen [DO], pH, turbidity, salinity, conductivity, oxidation-reduction potential [ORP], and temperature) will be field-analyzed with a Horiba U-22 or YSI water quality meter.

Subsequent surface water, sediment, seep and pore water samples will be analyzed for parameters which exceeded background concentrations and human health and/or ESVs during the initial sampling events. If metals exceed screening values, pH and acid volatile sulfide (AVS)/simultaneously extractable metals (SEM) will be analyzed in sediment.

Based upon historical sample results, SVOCs are not a concern at Site 7. The majority of SVOCs (including PAHs) detected in historical sampling were known laboratory contaminants. Although concentrations of PAHs detected in one surface soil collected in 1987 exceeded current RSLs, no PAHs were detected in subsequent investigations of nearby soil or in any other media sampled. Due to the lack of a defined hotspot or source area, detected concentrations of SVOCs are unlikely to be site-related. Additionally, the detected PAH concentrations were located within the footprint of the 1998 removal. Therefore, with concurrence from the USEPA and VDEQ, SVOCs will not be sampled for as part of the ERI.

During groundwater, pore water and surface water sampling (if completed), water quality parameters (i.e., DO, pH, turbidity, salinity, conductivity, ORP, and temperature) will be field-analyzed with a Horiba U-22 or YSI water quality meter.

The rationale for collecting specific samples is included in **Worksheet #17**.

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

What are the Project Action Limits (PALs)?

PALs are media-specific standards and criteria chosen for evaluation to help provide a conservative assessment of site conditions and determine if action is needed to address concentrations of chemicals present on-site. The following list presents a summary of the PALs for each media. **Worksheets #15-1** through **15-12** provide a list of the PALs for each constituent in each media.

- Surface and Subsurface Soil
  - WPNSTA Yorktown Base-Wide 95 percent upper tolerance limits (UTLs) (CH2M HILL, 2010)
  - USEPA Residential Soil RSLs (Updated May 2012), RSLs based on non-carcinogenic endpoints will be adjusted by dividing by 10, RSLs based on carcinogenic endpoints will be used as presented in the RSL Table
  - USEPA ESVs for plants and soil invertebrates, and other values from the literature
  - USEPA RSLs Maximum Contaminant Level (MCL)-based SSLs
  - USEPA RSLs Risk-Based SSLs
- Sediment Outfall
  - USEPA Residential Soil RSLs multiplied by 10 (Updated May 2012), RSLs based on non-carcinogenic endpoints will be adjusted by dividing by 10, RSLs based on carcinogenic endpoints will be used as presented in the RSL Table
  - Marine-based ecological sediment screening values from various literature-based sources
- Groundwater
  - Greater of Site-Specific Reference Samples or WPNSTA Yorktown Base-Wide UTLs (CH2M HILL, 2010)
  - USEPA Tap Water RSLs (Updated May 2012), RSLs based on non-carcinogenic endpoints will be adjusted by dividing by 10, RSLs based on carcinogenic endpoints will be used as presented in the RSL Table
  - USEPA Ambient Water Quality Criteria for the Protection of Aquatic Life and other marine-based ESVs from the literature
- Surface Water
  - USEPA Tap Water RSLs multiplied by 10 (Updated May 2012), RSLs based on non-carcinogenic endpoints will be adjusted by dividing by 10, RSLs based on carcinogenic endpoints will be used as presented in the RSL Table
  - USEPA Ambient Water Quality Criteria for the Protection of Aquatic Life and other marine-based ESVs from the literature

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

- Sediment
  - USEPA Residential Soil RSLs multiplied by 10 (Updated May 2012), RSLs based on non-carcinogenic endpoints will be adjusted by dividing by 10, RSLs based on carcinogenic endpoints will be used as presented in the RSL Table
  - Marine-based ecological sediment screening values from various literature-based sources

Specific PALs for seeps and pore water samples are not listed. These samples will be used to better understand fate and transport mechanisms. Decisions related to site risks and future actions will be determined from analytical results for other media.

In addition to PALs, project indicator limits (PILs) for groundwater were established to assist with determining if natural attenuation is occurring at the site. In order for geochemical parameter data to be meaningful, typically, more than one round of data is necessary. Therefore, it is anticipated that the most thorough evaluation will be of the results for the four existing wells which have been sampled previously. However, data from the new wells may also be used in future evaluations. PILs will be evaluated as a whole, as no individual parameter represents a definitive summary of site conditions. The parameters, their associated PILs, and explanation for inclusion are shown in **Table 1**.

For what will the data be used?

The data will be used to determine the nature and extent of contamination and associated risks attributable to historical CERCLA-related releases in the area of the former buildings upgradient of the Site 7 drainage and whether contamination warrants further removal actions or remediation. This determination will be based on quantitative HHRAs and ERAs.

How "good" do the data need to be in order to support the environmental decision?

The analytical data will be of the quantity and quality necessary to provide technically sound and defensible assessments of the nature and extent of contamination and potential risks to human and ecological receptors posed by the contaminants identified. QC sample requirements are detailed in **Worksheet #20**. QC samples will be collected according to standard operating procedures (SOPs) for the DV and the generation of a HHRA and ERA. For risk assessment and further action decisions, the laboratory will follow the Measurement Performance Criteria (MPC) in **Worksheet #12** for field QC samples and **Worksheets #24 and 28** for laboratory QC samples**.** These MPC are consistent with the DoD Quality Systems Manual (QSM) as applicable and laboratory in-house limits where the QSM does not apply.

In the instance that the laboratory limit of detection (LOD) for a specific constituent is greater than the corresponding PAL, any detection of this constituent above the 95 percent background UTL will be considered potentially site-related. In those cases where this specific constituent result is non-detect, the analyte will be considered not present.

In efforts to reach lower limits, the laboratory will report concentrations between the limit of quantitation (LOQ) and detection limit (DL) as estimated. These results will have a J qualifier applied to them indicating that they are quantitative estimates.

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

TABLE 1
Project Indicator Levels

Parameter	PIL	Justification
Methane	> 0.5 milligram per liter (mg/L)	Elevated methane levels are expected to be seen under highly reducing conditions as a byproduct of degradation by methanogenic bacteria and are a positive indicator that degradation of VOCs and some explosives can occur.
Ferrous Iron	> 1 mg/L	Elevated concentrations indicate the activity of iron-reducing bacteria and are a positive indication that reductive dechlorination of VOCs may be occurring.
Sulfate	< 20 mg/L	If sulfur compounds are present in the aquifer, higher concentrations of sulfate may compete with the reductive dechlorination pathway. Therefore, ideal conditions will maintain low sulfate levels.
Sulfide	> 1 mg/L	If sulfur compounds are present in the aquifer, higher concentrations of sulfide are more favorable to reductive dechlorination. Therefore, ideal conditions will maintain higher sulfide levels.
TOC	> 20 mg/L	TOC is an indicator of the total amount of organic matter available to microbial communities to use as a carbon source in the degradation of VOCs. Increasing TOC concentrations are a positive indicator of natural attenuation potential.
Nitrate	Baseline value to later determine decreasing trend	Nitrate data will be collected in the event that a natural attenuation or enhanced biological remedy is later needed for the site. Enhanced biological treatment methods which reduce aquifer conditions are generally expected to result in decreasing concentrations of nitrate.
Nitrite	Baseline value to later determine increasing trend	Nitrite data will be collected in the event that a natural attenuation or enhanced biological remedy is later needed for the site. Enhanced biological treatment methods which reduce aquifer conditions are generally expected to result in increasing concentrations of nitrite.
Chloride	Baseline value to later determine increasing trend	Chloride data will be collected in the event that a natural attenuation or enhanced biological remedy is later needed for the site. Enhanced biological treatment methods which reduce aquifer conditions are generally expected to result in increasing concentrations of chloride, if chlorinated compounds are being degraded.
Alkalinity	> 50 mg/L	A measurement of the available buffering capacity against pH change, which can affect the rate of degradation of chemicals. Decreasing alkalinity may indicate that pH conditions are becoming less optimal for reductive dechlorination.

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

Data, with the exception of geochemical and geotechnical data, will be validated by CH2M HILL using the procedures listed in **Worksheet #36**. A full level IV equivalent data package and QC sampling are required for these data. A Level IV equivalent data package includes a case narrative, all field sample results, QC forms, and raw data.

How much data are needed? (number of samples for each analytical group, matrix, and concentration)

The initial forty proposed soil sample locations, four proposed sediment outfall sample locations, and four existing and seven proposed monitoring well locations, are shown on **Figure 4**. At a minimum, an additional eight sediment and eight surface water samples will be collected during the second sampling event. Eight pore water, eight seeps, and an additional round of groundwater samples may also be collected in the second sampling event, if the initial soil, sediment outfall, and groundwater results indicate a potential risk.

Where, when, and how should the data be collected/generated?

The data will be collected and generated in accordance with the SOPs contained in this SAP. The first phase of the fieldwork is tentatively scheduled to begin in fall of 2012. Data will be validated by CH2M HILL and available for use approximately 7 weeks after the laboratory receives the samples.

Who will collect and generate the data?

CH2M HILL staff will collect the field samples with the aid of the drilling subcontractor and submit them for analysis to Empirical Laboratories, LLC, an offsite DoD Environmental Laboratory Accreditation Program (ELAP)-approved analytical laboratory (**Appendix B**). Empirical will send grain size samples to Beaver Engineering. CH2M HILL will oversee the subcontractor process.

How will the data be reported?

CH2M HILL will receive the data and will upload it into a centralized database used for Navy projects by the project team. Data will be presented in tabular format and evaluated against prescribed screening criteria as previously outlined. The results of the investigations will be documented in an ERI Report.

How will the data be archived?

Data will be archived according to procedures dictated via the Navy CLEAN program and contract and will be uploaded into the Navy Installation Restoration Information System (NIRIS). At the end of the project, archived data will be returned to the Navy.

List the PQOs in the form of if/then qualitative and quantitative statements.

Soil, sediment outfall, and groundwater samples from the first sampling event will be evaluated using multiple lines of evidence, including background sample results, ecological screening levels, SSLs, and RSLs. Particular emphasis will be placed on identification of potential source areas and evaluating potential downgradient transport pathways to the wetland area adjacent to Felgates Creek. Sample locations were chosen within the former building footprints, associated conveyor areas, and loading/unloading zones in the vicinity of the former building footprints. Sample locations selected downgradient of the former building footprints were established by identifying the most likely potential release points and contaminant accumulation areas based on the site history and surface topography. The samples downgradient of the former building footprints will be used to evaluate surface runoff and soil deposition that may have occurred during plant operation or as a result of the building demolition. In addition, one sample will be collected from the most upgradient point of the remediated

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

drainage area, to confirm if surface runoff or building demolition have resulted in recontamination of the previously remediated drainage area.

If concentrations of any contaminants in the soil, sediment outfall, or groundwater samples from the first round of sampling are present at levels posing potentially unacceptable risk to human or ecological receptors based on risk screening, concentrations will be compared to base-wide and site-specific upgradient background levels.

If potential unacceptable risk to human or ecological receptors exist based on the first round of sampling, then pore water, seep, and additional groundwater samples will be collected during the second round of sampling, at the same time as the sediment and surface water samples.

If necessary, pore water and seep sample locations will be selected along with the locations of the sediment and surface water samples with team consensus at the locations most likely to be impacted by site-related contamination. This determination evaluation will consider likely transport pathways and groundwater exceedances of surface water screening values.

If concentrations of any contaminants are present in total groundwater at levels exceeding MCLs, concentrations will be compared to base-wide and site-specific upgradient background levels.

If concentrations of any contaminants in the soil, sediment outfall, or groundwater samples exceed RSLs, ecological screening criteria, or SSLs and exceed both site-specific and basewide background, the team will meet to evaluate the data and decide on the contaminants to be analyzed in the second round of sampling for sediment and surface water, and pore water, seep and additional groundwater if determined necessary.

If review of the groundwater data indicates that the dissolved and total recoverable metals data are dissimilar then the dissolved data will be considered in accordance with the 1992 USEPA Region III Guidance on the Selection of Metal Results from Monitoring Well Samples for Use in the Quantitative Assessment of Risk.

If concentrations of contaminants above background in total groundwater are present at levels above MCLs or potentially posing unacceptable risk, the team will review the total and dissolved data to determine if there is a significant difference between the two datasets. If the elevated concentrations could be a result of suspended sediment based on the two datasets, the team will discuss possible use of the dissolved data for decision-making.

If concentrations of contaminants potentially posing unacceptable risk are present at concentrations greater than background, the risk will be considered site-related.

If a potentially unacceptable site-related risk is identified in soil and the team agrees that the nature and extent of contamination has been sufficiently defined to support a removal, a Non-time-critical Removal Action (NTCRA) will be considered.

If no unacceptable risks or MCL exceedances are identified during the first or second round of sampling that are attributable to the site, no further investigation or action will be warranted.

If unacceptable site-related risks are identified for soil, but not for groundwater, no further investigation or action will be warranted for groundwater.

If unacceptable risk is identified for groundwater, but not for soil, and/or if concentrations greater than background and MCLs are found in groundwater in the absence of unacceptable risk, an evaluation of groundwater monitoring alternatives will be considered.

If the results of the first and second round sampling events suggest that deeper subsurface soil samples (greater than 24 inches) would be beneficial as part of a future investigation or remedy implementation, then the Partnering Team will review the data and decide if deeper samples are necessary.

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

If contaminants are noted in the new monitoring wells during the first groundwater sampling event at concentrations likely to result in deep groundwater contamination, then the Partnering Team will review the data and one or more deep, double cased wells may also be installed under this SAP, although it is not anticipated that deep wells would be beneficial based on existing site data (low concentrations of contaminants with specific gravities greater than water). If deep monitoring wells are determined necessary, the analytical suite for any deep wells installed will be consistent with the strategy described for the shallow wells.

If concentrations of site-related contaminants in various media pose potential human health or ecological risks based on the HHRA or ERA, an EE/CA or FS may be completed to address the contamination.

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SAP Worksheet #12-1—Measurement Performance Criteria Table- Field QC Samples

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: VOCs

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Equipment Rinsate Blank	VOCs	NA, using disposable equipment	Contamination /Bias	NA	S&A
Cooler Temperature Blank		One per cooler to the laboratory	Contamination /Bias	< 6 degrees Celsius (°C), not frozen	S
Field Duplicate		One per 10 samples per matrix	Accuracy /Precision	Relative percent difference (RPD) ≤ 30 percent	S&A

SAP Worksheet #12-2—Measurement Performance Criteria Table- Field QC Samples

Matrix: Surface Soil and Subsurface Soil

Analytical Group: Pesticides

Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Equipment Rinsate Blank	Pesticides	NA, using disposable equipment	Contamination /Bias	NA	S&A
Cooler Temperature Blank		One per cooler to the laboratory	Contamination /Bias	< 6 °C, not frozen	S
Field Duplicate		One per 10 samples per matrix	Accuracy /Precision	RPD ≤ 30 percent	S&A

SAP Worksheet #12-3—Measurement Performance Criteria Table- Field QC Samples

Matrix: Surface Soil and Subsurface Soil

Analytical Group: PCBs

Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Equipment Rinsate Blank	PCBs	NA, using disposable equipment	Contamination /Bias	NA	S&A
Cooler Temperature Blank		One per cooler to the laboratory	Contamination /Bias	< 6 °C, not frozen	S
Field Duplicate		One per 10 samples per matrix	Accuracy /Precision	RPD ≤ 30 percent	S&A

SAP Worksheet #12-4—Measurement Performance Criteria Table- Field QC Samples

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: Explosives

Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Equipment Rinsate Blank	Explosives	One per day of sampling per type of equipment	Contamination /Bias	no analyte detected >1/2 LOQ	S&A
Cooler Temperature Blank		One per cooler to the laboratory	Contamination /Bias	< 6 °C, not frozen	S
Field Duplicate		One per 10 samples per matrix	Accuracy /Precision	Explosives by SW-846 8330: RPD ≤ 30 percent Perchlorate by SW-846 6850: RPD ≤ 15 percent	S&A

SAP Worksheet #12-5—Measurement Performance Criteria Table- Field QC Samples

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: Metals/Cyanide

Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Equipment Rinsate Blank	Metals/ Cyanide	One per day of sampling per type of equipment	Contamination /Bias	no analyte detected >1/2 LOQ	S&A
Cooler Temperature Blank		One per cooler to the laboratory	Contamination /Bias	< 6 °C, not frozen	S
Field Duplicate		One per 10 samples per matrix	Accuracy /Precision	RPD ≤ 20 percent	S&A

SAP Worksheet #12-6—Measurement Performance Criteria Table- Field QC Samples

Matrix: Surface Soil, Subsurface Soil, and/or Sediment

Analytical Group: Wet Chemistry (pH, TOC) and AVS/SEM

Concentration Level: Medium /Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Cooler Temperature Blank	Wet chemistry and AVS/SEM	One per cooler to the laboratory	Contamination /Bias	< 6 °C, not frozen	S

SAP Worksheet #12-7—Measurement Performance Criteria Table- Field QC Samples

Matrix: Groundwater, Pore Water, Seep, Surface Water[1]

Analytical Group: Volatile organic analyte (VOA)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Equipment Rinsate Blank	VOA	One per day of sampling per type of equipment	Contamination /Bias	no analyte detected >1/2 LOQ	S&A
Cooler Temperature Blank		One per cooler to the laboratory	Contamination /Bias	< 6 °C, not frozen	S
Field Duplicate		One per 10 samples per matrix	Accuracy /Precision	RPD ≤ 30 percent	S&A

[1] No Equipment Rinsate Blank will be collected for surface water samples.

SAP Worksheet #12-8—Measurement Performance Criteria Table- Field QC Samples

Matrix: Groundwater

Analytical Group: Pesticides

Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Equipment Rinsate Blank	Pesticides	One per day of sampling per type of equipment	Contamination /Bias	no analyte detected >1/2 LOQ	S&A
Cooler Temperature Blank		One per cooler to the laboratory	Contamination /Bias	< 6 °C, not frozen	S
Field Duplicate		One per 10 samples per matrix	Accuracy /Precision	RPD ≤ 30 percent	S&A

SAP Worksheet #12-9—Measurement Performance Criteria Table- Field QC Samples

Matrix: Groundwater

Analytical Group: PCBs

Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Equipment Rinsate Blank	PCBs	One per day of sampling per type of equipment	Contamination /Bias	no analyte detected >1/2 LOQ	S&A
Cooler Temperature Blank		One per cooler to the laboratory	Contamination /Bias	< 6 °C, not frozen	S
Field Duplicate		One per 10 samples per matrix	Accuracy /Precision	RPD ≤ 30 percent	S&A

SAP Worksheet #12-10—Measurement Performance Criteria Table- Field QC Samples

Matrix: Groundwater, Pore Water, Seep, Surface Water[1]

Analytical Group: Explosives

Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Equipment Rinsate Blank	Explosives	One per day of sampling per type of equipment	Contamination / Bias	no analyte detected >1/2 LOQ	S&A
Cooler Temperature Blank		One per cooler to the laboratory	Contamination / Bias	< 6 °C, not frozen	S
Field Duplicate		One per 10 samples per matrix	Accuracy / Precision	Explosives by SW-846 8330: RPD ≤ 30 percent Perchlorate by SW-846 6850: RPD ≤ 15 percent	S&A

[1] No Equipment Rinsate Blank will be collected for surface water samples.

SAP Worksheet #12-11—Measurement Performance Criteria Table- Field QC Samples

Matrix: Groundwater, Pore Water, Seep, Surface Water[1]

Analytical Group: Total Metals/Cyanide and Dissolved Metals

Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Equipment Rinsate Blank	Metals/ cyanide	One per day of sampling per type of equipment	Contamination /Bias	no analyte detected >1/2 LOQ	S&A
Cooler Temperature Blank		One per cooler to the laboratory	Contamination /Bias	< 6 °C, not frozen	S
Field Duplicate		One per 10 samples per matrix	Accuracy /Precision	RPD ≤ 20 percent	S&A

[1] No Equipment Rinsate Blank will be collected for surface water samples.

SAP Worksheet #12-12—Measurement Performance Criteria Table- Field QC Samples

Matrix: Groundwater

Analytical Group: Wet Chemistry (Ferrous Iron, Sulfide, Sulfate, TOC, Methane, Alkalinity)

Concentration Level: Medium /Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Cooler Temperature Blank	Wet chemistry	One per cooler to the laboratory	Contamination /Bias	< 6 °C, not frozen	S

SAP Worksheet #13—Secondary Data Criteria and Limitations Table

Secondary Data	Data Source	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
Yorktown Background Dataset	*Final Background Study Report, Naval Weapons Station Yorktown and Cheatham Annex.* May 2011	CH2M HILL	Analytical data will be used to determine if contaminant levels exceed Station background concentrations. Note: this document is currently in draft form and will likely be finalized prior to receipt of data.	None Known
Sites 7 Historical Data	*Final LTM Report, Site 7, Naval Weapons Station Yorktown, Yorktown, Virginia*. November 2010	CH2M HILL	Data can be used to evaluate trends in groundwater contaminant data and geochemical data (for the purpose of the natural attenuation evaluation)	None Known

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SAP Worksheet #14—Summary of Project Tasks

Project Logistics

- In general, work will be performed in Level D personal protective equipment (PPE), which includes hardhat, safety glasses, safety toed boots, and hearing protection. Optional PPE includes the use of Tyvek coveralls as necessary. Upgrades to higher levels of PPE are discussed in the Health and Safety Plan (HSP), which will be provided as a separate document from this UFP-SAP.
- All field activities will take place during normal daylight working hours.
- Following the investigational activities, the site will be restored to its original condition to the satisfaction of the property owner.

Project Tasks

Applicable SOPs for project tasks outlined in this section are listed on **Worksheet #21** and provided in **Appendix A**.

Utility Clearance

- Utilities will be cleared before beginning intrusive activities. CH2M HILL will coordinate utility clearance with Miss Utility of Virginia and the Base's approving authority. Additionally, a separate utilities subcontractor will be procured to ensure the accuracy of the utility markings. Any proposed monitoring well locations in close proximity to utility locations will be relocated to avoid impact to utilities while continuing to meet the intent of the sampling rationale.

Investigational Activities

- **Soil Sampling –** Soil samples will be collected using a hand auger. Surface soil samples will be collected from 0 to 6 inches bgs, while subsurface samples will be collected from a depth of 6 to 24 inches bgs. Samples collected for VOCs analysis will be placed directly into Terracores. After the VOC sample is collected, the remainder of the soil will be homogenized in a stainless steel bowl and then transferred to the appropriate sample containers for the other analytes.
- **Sediment Outfall Sampling –** Sediment outfall samples will be collected using a stainless steel spoon or trowel. Sediment outfall samples will be collected from 0 to 4 inches bgs.   Samples collected for VOCs analysis will be placed directly into Terracores. After the VOC sample is collected, the remainder of the sediment will be homogenized in a stainless steel bowl and then transferred to the appropriate sample containers for the other analytes.
- **Monitoring Well Installation –** Five downgradient monitoring wells and two upgradient monitoring wells will be installed in the Yorktown Eastover aquifer during investigation activities. Based on wells installed at adjacent Site 6, a finer grained, dense sand unit is present at approximately 50 feet bgs in the aquifer that impedes downward contaminant migration and eliminates the need to install wells at the base of the aquifer, which extends to approximately 90 feet bgs. Well depths and screened intervals will be discussed with the partnering team prior to installation.

SAP Worksheet #14—Summary of Project Tasks (continued)

- **Monitoring Well Construction** - Each new monitoring well will be constructed with 2-inch nominal-diameter Schedule 40 polyvinyl chloride (PVC) screen and riser. The monitoring well screen will be 0.010-inch machine slotted. A silica filter pack will be placed around the annular space of the well screen from the bottom of the boring extending to 2 feet above the top of the screen. A 2-foot-thick bentonite layer will be placed above the sand pack. After the bentonite has been hydrated, a cement-bentonite grout will be placed in the remaining annular space. The monitoring wells will be completed with an above-grade protective casing with a watertight steel cover. A locking watertight cap will be placed on the PVC pipe and the wells clearly marked. Wells will be surrounded with bollards and locked.

- **Monitoring Well Development**--Each new monitoring well will be developed using a submersible pump. At least three well volumes of water will be removed, in addition to any amount of water which may have been added during the installation process. Development will continue until water quality parameters have stabilized within 10 percent for three consecutive readings and turbidity has been reduced to the extent practicable (preferably less than 10 nephelometric turbidity units [NTUs]). Development information, including turbidity, pH, specific conductivity, temperature, and gallons removed, will be recorded in the field logbook.

- **Groundwater Sampling**--All site monitoring wells with the exception of 7GW04 will be sampled using a peristaltic or submersible pump and disposable tubing following low-flow sampling protocol. Groundwater quality parameters (pH, specific conductance, turbidity, DO, temperature, salinity, and ORP) will be recorded and stabilized before a sample is collected.

- **Surface Water Sampling –**All sample locations will be approached from downstream to avoid disturbance of bottom sediments as much as possible. Prior to sample collection, water quality data will be measured from the top, middle, and bottom of the water column (where applicable) using a Horiba U-22 water quality meter (pH, conductivity, turbidity, DO, temperature, salinity, and ORP). To facilitate sample collection, a clean, unpreserved sample container will be gently submerged within the surface water with the mouth pointed upstream and the bottle tilted slightly downstream. Bubbles and floating materials will be prevented from entering the bottle. When the bottle is full, it will be gently removed from the water and the surface water sample transferred to the laboratory supplied bottleware.

- **Sediment Sampling –**All sediment samples will be collected from 0- to 4-inches bgs. With the exception of VOC and AVS/SEM samples, sediment will be homogenized in stainless bowls prior to placement in laboratory prepared sample containers. Samples collected for VOCs and AVS/SEM analysis will be placed directly into sample containers.

- **Pore Water Sampling –** If collected, pore water samples will be sampled from passive diffusion bags placed in the first 6 inches of sediment. Samples will be collected after 2 weeks have passed. Pore water samples will not be collected if VOCs are not identified as posing potential risk at the site.

- **Seep Sampling –** If collected, seeps samples will be collected directly from the seep into a clean, laboratory prepared sample container and transfer to preserved containers as necessary.

SAP Worksheet #14—Summary of Project Tasks (continued)

Equipment Decontamination

- All non-disposable sampling equipment will be decontaminated before use and immediately after each use in accordance with applicable SOPs (**Appendix A**). The water level indicator will be rinsed with deionized water between each measurement. Heavy equipment such as drill rigs (e.g., augers, rods, split spoons) will be steam-cleaned before use at each new monitoring well location. Monitoring well risers and screens will also be steam-cleaned using the same procedure, unless they are certified by the manufacturer as clean and the plastic seals intact. A decontamination pad will be set up to prevent runoff of the decontamination water and to allow easy collection of decontamination fluids.

Investigation-derived Waste Handling

- Investigation-derived waste (IDW) generated during investigational activities at Site 7 will include soil cuttings, well purge water and solutions used to decontaminate drilling and hand augering equipment. Aqueous IDW and soil cuttings will be containerized in approved 55-gallon drums.
- IDW will be characterized for appropriate offsite disposal and will be removed from the site within 90 days of generation. Soil and aqueous IDW generated during monitoring well installation and sampling will be sampled, and characterized for appropriate offsite disposal.

Quality Control

- SOPs for field (**Appendix A**) and laboratory (**Appendix B**) activities being performed will be implemented.
- A summary of daily field activities will be documented in a field log book; this log book will also detail sampling activities and information regarding boring logs, well construction, and well development.
- QC samples to be collected are outlined on **Worksheet #20**.

Surveying

- Any newly installed monitoring wells will be horizontally (± 0.1 foot) and vertically (± 0.01 foot) located by a Virginia-licensed surveyor.The locations of all soil, outfall sediment, surface water/sediment, seep, and pore water locations will be recorded via GPS.

Analytical Tasks

- The laboratory will maintain, test, inspect, and calibrate analytical instruments (**Worksheets #24 and #25**).
- The laboratory will process and prepare samples for analysis.

Data Management

- See **Appendix D**, Navy CLEAN Data Management Plan for all data management procedures.

SAP Worksheet #14—Summary of Project Tasks (continued)

- Procedures for data tracking, storage, archiving, retrieval and security for both electronic and hardcopy data:
  - See the Navy CLEAN Data Management Plan for detailed information (**Appendix D**)
  - The Project PDM, Gwen Buckley, is responsible for data tracking and storage
  - Stacy Davenport of CH2M HILL will coordinate archiving and retrieval of data

Project Assessment/Audit

- **Worksheets #31 and #32**

Data Review

- DV (**Worksheets #35 and #36**)

SAP Worksheet #15-1A—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil
Analytical Group: VOA

Analyte	Chemical Abstract Service (CAS) Number[5]	Residential Soil RSL (adjusted)[1] (micrograms per kilogram [µg/kg])	ESV[1,4] (µg/kg)	Risk-Based SSL[1] (µg//kg)	MCL-Based SSL[1] (µg/kg)	Project Quantitation Limit (PQL) Goal[2] (µg/kg)	Laboratory-Specific (µg/kg)			Laboratory Control Sample (LCS) and Matrix Spike(MS)/Matrix Spike Duplicate (MSD) Percent Recovery (%R) and %RPD Limits[3]		
							LOQ	LOD	DL	Lower Control Limit (LCL)	Upper Control Limit (UCL)	RPD
1,1,1-Trichloroethane	71-55-6	640,000	1,025	2600	70	35	5.00	2.50	1.25	70	135	30
1,1,2,2-Tetrachloroethane	79-34-5	560	5,000	0.026	No Criteria (NC)	0.013	5.00	2.50	1.25	55	130	30
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	76-13-1	910,000	NC	130000	NC	65000	10.00	5.00	2.50	**20**	**185**	30
1,1,2-Trichloroethane	79-00-5	160	2,000	0.077	1.6	0.0385	5.00	2.50	1.25	60	125	30
1,1-Dichloroethane	75-34-3	3,300	548	0.68	NC	0.34	5.00	2.50	1.25	75	125	30
1,1-Dichloroethene	75-35-4	24,000	173	93	2.5	1.25	5.00	2.50	1.25	65	135	30
1,2,3-Trichlorobenzene	87-61-6	4,900	1,150	15	NC	7.5	5.00	2.50	1.25	55	140	30
1,2,4-Trichlorobenzene	120-82-1	6,200	1,270	2.9	0.2	0.1	5.00	2.50	1.25	65	130	30
1,2-Dibromo-3-chloropropane	96-12-8	5.4	NC	0.00014	0.086	0.00007	10.00	5.00	2.50	40	135	30
1,2-Dibromoethane	106-93-4	34	300	0.0018	0.014	0.0009	5.00	2.50	1.25	70	125	30
1,2-Dichlorobenzene (DCB)	95-50-1	190,000	1,000	270	580	135	5.00	2.50	1.25	75	120	30
1,2-Dichloroethane	107-06-2	430	2,190	0.042	1.4	0.021	5.00	2.50	1.25	70	135	30
1,2-Dichloropropane	78-87-5	940	38,800	0.13	1.7	0.065	5.00	2.50	1.25	70	120	30
1,3-DCB	541-73-1	NC	1,000	NC	NC	500	5.00	2.50	1.25	70	125	30
1,4-DCB	106-46-7	2,400	1,280	0.4	72	0.2	5.00	2.50	1.25	70	125	30
2-Butanone	78-93-3	2,800,000	NC	1000	NC	500	10.00	5.00	2.50	30	160	30
2-Hexanone	591-78-6	21,000	NC	7.9	NC	3.95	5.00	2.50	1.25	45	145	30
4-Methyl-2-pentanone	108-10-1	530,000	NC	230	NC	115	5.00	2.50	1.25	45	145	30
Acetone	67-64-1	6,100,000	NC	3,050,000	2400	NC	3,050,000 20.00	10.00	5.00	20	160	30

SAP Worksheet #15-1A—Reference Limits and Evaluation Table (continued)

Analyte	CAS Number[5]	Residential Soil RSL (adjusted)[1] (µg/kg)	ESV[1,4] (µg/kg)	Risk-Based SSL[1] (µg/kg)	MCL-Based SSL[1] (µg/kg)	PQL Goal[2] (µg/kg)	Laboratory-Specific (µg/kg)			LCS, MS, and MSD %R and %RPD Limits[3]		
							LOQ	**LOD**	**DL**	**LCL**	**UCL**	**RPD**
Benzene	71-43-2	1,100	1,140	0.2	2.6	0.1	5.00	2.50	1.25	75	125	30
Bromochloromethane	74-97-5	16,000	NC	21	NC	10.5	5.00	2.50	1.25	70	125	30
Bromodichloromethane	75-27-4	270	NC	0.032	22	0.016	5.00	2.50	1.25	70	130	30
Bromoform	75-25-2	62,000	300	2.1	21	1.05	5.00	2.50	1.25	55	135	30
Bromomethane	74-83-9	730	NC	1.8	NC	0.9	10.00	5.00	2.50	30	160	30
Carbon disulfide	75-15-0	82,000	NC	210	NC	105	5.00	2.50	1.25	45	160	30
Carbon tetrachloride	56-23-5	610	3,400	0.15	1.9	0.075	5.00	2.50	1.25	65	135	30
Chlorobenzene	108-90-7	29,000	2,400	49	68	24.5	5.00	2.50	1.25	75	125	30
Chloroethane	75-00-3	1,500,000	5,000	5900	NC	2500	10.00	5.00	2.50	40	155	30
Chloroform	67-66-3	290	1,844	0.053	22	0.0265	5.00	2.50	1.25	70	125	30
Chloromethane	74-87-3	12,000	5,000	49	NC	24.5	10.00	5.00	2.50	50	130	30
cis-1,2-Dichloroethene	156-59-2	16,000	447	8.2	21	4.1	5.00	2.50	1.25	65	125	30
cis-1,3-Dichloropropene	10061-01-5	1,700	5,000	0.15	NC	0.075	5.00	2.50	1.25	70	125	30
Cyclohexane	110-82-7	120,000	6,000	13000	NC	3000	5.00	2.50	1.25	**65**	**140**	30
Dibromochloromethane	124-48-1	680	NC	0.039	21	0.0195	5.00	2.50	1.25	65	130	30
Dichlorodifluoromethane (Freon-12)	75-71-8	9,400	NC	300	NC	150	10.00	5.00	2.50	35	135	30
Ethylbenzene	100-41-4	5,400	1,815	1.5	780	0.75	5.00	2.50	1.25	75	125	30
Isopropylbenzene	98-82-8	210,000	NC	640	NC	320	5.00	2.50	1.25	75	130	30
m- and p-Xylene	m&pXYLENE	59,000	1,300	180	NC	90	10.00	5.00	2.50	80	125	30
Methyl acetate	79-20-9	7,800,000	NC	3200	NC	1600	10.00	5.00	2.50	**45**	**265**	30
Methylcyclohexane	108-87-2	NC	NC	NC	NC	Lab LOD	5.00	2.50	1.25	**65**	**135**	30
Methylene chloride	75-09-2	36,000	1,250	2.5	1.3	0.65	10.00	5.00	2.50	55	140	30
Methyl-tert-butyl ether (MTBE)	1634-04-4	43,000	NC	2.8	NC	1.4	5.00	2.50	1.25	**55**	**150**	30
o-Xylene	95-47-6	69,000	1,300	190	NC	95	5.00	2.50	1.25	80	120	30
Styrene	100-42-5	630,000	64,000	1200	110	55	5.00	2.50	1.25	75	125	30
Tetrachloroethene	127-18-4	8,600	179	4.4	2.3	1.15	5.00	2.50	1.25	65	140	30
Toluene	108-88-3	500,000	40,000	590	690	295	5.00	2.50	1.25	70	125	30
trans-1,2-Dichloroethene	156-60-5	15,000	447	25	29	12.5	5.00	2.50	1.25	65	135	30
trans-1,3-Dichloropropene	10061-02-6	1,700	5,000	0.15	NC	0.075	5.00	2.50	1.25	65	125	30
Trichloroethene	79-01-6	440	500	0.16	1.8	0.08	5.00	2.50	1.25	75	125	30
Trichlorofluoromethane (Freon-11)	75-69-4	79,000	NC	690	NC	345	10.00	5.00	2.50	25	185	30
Vinyl chloride	75-01-4	60	412	0.0053	0.69	0.00265	5.00	2.50	1.25	60	125	30

[1] PALs were developed to be protective of human health and the environment. Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs. Note that ESVs are only applicable to soil samples that are collected from less than 24-inches bgs; sources of ESVs are provided in Appendix F.

[2] PQL Goals are equal to half the minimum of the applicable criteria (PALs).

[3] DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. **Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.**

[4] The ESV value for o-xylenes and m- and p-xylenes is the xylenes (total) ESV.

[5] The CAS Number for m- and p-xylenes is a contractor-specific identification (ID) number.

NC indicates cases where there is no criteria for an analyte.

SAP Worksheet #15-1B—Reference Limits and Evaluation Table

Matrix: Sediment

Analytical Group: VOA

Analyte	CAS Number[4]	Residential Soil RSL (adjusted) X 10 for SD[1] (µg/kg)	ESV[1] (µg/kg)	PQL Goal[2] (µg/kg)	Laboratory-Specific (µg/kg)			LCS, MS, and MSD %R and %RPD Limits[3]		
					LOQ	**LOD**	**DL**	**LCL**	**UCL**	**RPD**
1,1,1-Trichloroethane	71-55-6	640,000	856	428	5.00	2.50	1.25	70	135	30
1,1,2,2-Tetrachloroethane	79-34-5	5,600	202	101	5.00	2.50	1.25	55	130	30
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	76-13-1	910,000	NC	Lab LOD	10.00	5.00	2.50	**20**	**185**	30
1,1,2-Trichloroethane	79-00-5	1,600	570	285	5.00	2.50	1.25	60	125	30
1,1-Dichloroethane	75-34-3	33,000	NC	16,500	5.00	2.50	1.25	75	125	30
1,1-Dichloroethene	75-35-4	240,000	2,782	1,391	5.00	2.50	1.25	65	135	30
1,2,3-Trichlorobenzene	87-61-6	49,000	NC	24,500	5.00	2.50	1.25	60	130	30
1,2,4-Trichlorobenzene	120-82-1	62,000	473	237	5.00	2.50	1.25	65	130	30
1,2-Dibromo-3-chloropropane	96-12-8	54	NC	27	10.00	5.00	2.50	40	135	30
1,2-Dibromoethane	106-93-4	340	NC	170	5.00	2.50	1.25	70	125	30
1,2-DCB	95-50-1	380,000	989	495	5.00	2.50	1.25	75	120	30
1,2-Dichloroethane	107-06-2	4,300	NC	2,150	5.00	2.50	1.25	70	135	30
1,2-Dichloropropane	78-87-5	9,400	NC	4,450	5.00	2.50	1.25	70	120	30
1,3-DCB	541-73-1	NC	842	421	5.00	2.50	1.25	70	125	30
1,4-DCB	106-46-7	24,000	110	55	5.00	2.50	1.25	70	125	30
2-Butanone	78-93-3	28,000,000	NC	14,000,000	10.00	5.00	2.50	30	160	30
2-Hexanone	591-78-6	210,000	NC	105,000	5.00	2.50	1.25	45	145	30
4-Methyl-2-pentanone	108-10-1	3,400,000	NC	2,650,000	5.00	2.50	1.25	45	145	30

SAP Worksheet #15-1B—Reference Limits and Evaluation Table (continued)

Analyte	CAS Number[4]	Residential Soil RSL (adjusted) X 10 for SD[1] (µg/kg)	ESV[1] (µg/kg)	PQL Goal[2] (µg/kg)	Laboratory-Specific (µg/kg)			LCS, MS, and MSD %R and %RPD Limits[3]		
					LOQ	LOD	DL	LCL	UCL	RPD
Acetone	67-64-1	61,000,000	NC	30,500,000	20.00	10.00	5.00	20	160	30
Benzene	71-43-2	11,000	137	69	5.00	2.50	1.25	75	125	30
Bromochloromethane	74-97-5	160,000	NC	80,000	5.00	2.50	1.25	70	125	30
Bromodichloromethane	75-27-4	2,700	NC	1,350	5.00	2.50	1.25	70	130	30
Bromoform	75-25-2	620,000	1,308	654	5.00	2.50	1.25	55	135	30
Bromomethane	74-83-9	7300	NC	3,650	10.00	5.00	2.50	30	160	30
Carbon disulfide	75-15-0	740,000	NC	410,000	5.00	2.50	1.25	45	160	30
Carbon tetrachloride	56-23-5	6,100	7,244	3,050	5.00	2.50	1.25	65	135	30
Chlorobenzene	108-90-7	290,000	162	81	5.00	2.50	1.25	75	125	30
Chloroethane	75-00-3	2,100,000	NC	1,050,000	10.00	5.00	2.50	40	155	30
Chloroform	67-66-3	2,900	NC	1,450	5.00	2.50	1.25	70	125	30
Chloromethane	74-87-3	120,000	NC	60,000	10.00	5.00	2.50	50	130	30
cis-1,2-Dichloroethene	156-59-2	160,000	NC	80,000	5.00	2.50	1.25	65	125	30
cis-1,3-Dichloropropene	10061-01-5	17,000	7.31	4	5.00	2.50	1.25	70	125	30
Cyclohexane	110-82-7	120,000	NC	60,000	5.00	2.50	1.25	**65**	**140**	30
Dibromochloromethane	124-48-1	6,800	NC	3,400	5.00	2.50	1.25	65	130	30
Dichlorodifluoromethane (Freon-12)	75-71-8	94,000	NC	47,000	10.00	5.00	2.50	35	135	30
Ethylbenzene	100-41-4	54,000	305	153	5.00	2.50	1.25	75	125	30
Isopropylbenzene	98-82-8	270,000	NC	100,000	5.00	2.50	1.25	75	130	30
m- and p-Xylene	m&pXYLENE	390,000	NC	100,000	10.00	5.00	2.50	80	125	30
Methyl acetate	79-20-9	29,000,000	NC	15,000	10.00	5.00	2.50	**45**	**265**	30
Methylcyclohexane	108-87-2	NC	NC	Lab LOD	5.00	2.50	1.25	**65**	**135**	30
Methylene chloride	75-09-2	360,000	NC	55,000	10.00	5.00	2.50	55	140	30
MTBE	1634-04-4	430,000	NC	215,000	5.00	2.50	1.25	**55**	150	30
o-Xylene	95-47-6	430,000	NC	1200,000	5.00	2.50	1.25	75	125	30
Styrene	100-42-5	870,000	7,069	3,535	5.00	2.50	1.25	75	125	30
Tetrachloroethene	127-18-4	86,000	57	29	5.00	2.50	1.25	65	140	30
Toluene	108-88-3	820,000	1,086	543	5.00	2.50	1.25	70	125	30
trans-1,2-Dichloroethene	156-60-5	150,000	NC	75,000	5.00	2.50	1.25	65	135	30
trans-1,3-Dichloropropene	10061-02-6	17,000	7.31	4	5.00	2.50	1.25	65	125	30
Trichloroethene	79-01-6	28,000	41	21	5.00	2.50	1.25	75	125	30
Trichlorofluoromethane (Freon-11)	75-69-4	4,400	NC	2,200	10.00	5.00	2.50	25	185	30
Vinyl chloride	75-01-4	600	NC	300	5.00	2.50	1.25	60	125	30

[1] PALs were developed to be protective of human health and the environment. Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs. The sources of the ESVs are provided in Appendix F.
[2] PQL Goals are equal to half the minimum of the applicable criteria (PALs).
[3] DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.
[4] The CAS Number for m- and p-xylenes is a contractor-specific ID number.
NC indicates cases where there is no criteria for an analyte.

SAP Worksheet #15-2A—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: Pesticides

Analyte	CAS Number	Residential Soil RSL (adjusted)[1] (µg/kg)	ESV[1] (µg/kg)	Risk-Based SSL[1] (µg/kg)	MCL-Based SSL[1] (µg/kg)	PQL Goal[2] (µg/kg)	Laboratory-Specific (µg/kg)			LCS, MS, and MSD %R and %RPD Limits[3]		
							LOQ	LOD	DL	LCL	UCL	RPD
4,4'- dichlorodiphenyldichloroethane (DDD)	72-54-8	2000	583	0.036	NC	0.018	0.670	0.340	0.170	30	135	30
4,4'-dichlorodiphenyldichloroethylene (DDE)	72-55-9	1400	114	0.13	NC	0.065	0.670	0.340	0.170	70	125	30
4,4'- dichlorodiphenyltrichloroethane (DDT)	50-29-3	1700	100	0.13	NC	0.065	0.670	0.340	0.170	45	140	30
Aldrin	309-00-2	29	3.63	0.21	1.2	0.105	0.670	0.340	0.110	45	140	30
alpha-benzene hexachloride (BHC)	319-84-6	77	226	0.14	33	0.07	0.670	0.340	0.110	60	125	30
alpha-Chlordane	5103-71-9	1600	11	0.034	NC	0.017	0.670	0.340	0.110	65	120	30
beta-BHC	319-85-7	270	342	0.068	4.1	0.034	0.670	0.340	0.110	60	125	30
delta-BHC	319-86-8	270	226	1100	NC	113	0.670	0.340	0.110	55	130	30
Dieldrin	60-57-1	30	10.5	0.061	NC	0.0305	0.670	0.340	0.170	65	125	30
Endosulfan I	959-98-8	37000	6.32	46	NC	3.16	0.670	0.340	0.110	15	135	30
Endosulfan II	33213-65-9	37000	6.32	68	81	3.16	0.670	0.340	0.170	35	140	30
Endosulfan sulfate	1031-07-8	37000	6.32	1100	NC	3.16	0.670	0.340	0.170	60	135	30
Endrin	72-20-8	1800	1.95	66	NC	0.975	0.670	0.340	0.170	60	135	30
Endrin aldehyde	7421-93-4	1800	1.95	1100	NC	0.975	0.670	0.340	0.170	35	145	30
Endrin ketone	53494-70-5	1800	1.95	67	NC	0.975	0.670	0.340	0.170	65	135	30
gamma-BHC (Lindane)	58-89-9	520	7.75	1500	2200	3.875	0.670	0.340	0.110	60	125	30
gamma-Chlordane	5103-74-2	1600	11	68	NC	5.5	0.670	0.340	0.110	65	125	30
Heptachlor	76-44-8	110	52.9	68	NC	26.45	0.670	0.340	0.110	50	140	30
Heptachlor epoxide	1024-57-3	53	52.9	1.8	NC	0.9	0.670	0.340	0.110	65	130	30
Methoxychlor	72-43-5	31000	500	1.8	NC	0.9	0.670	0.340	0.110	55	145	30
Toxaphene	8001-35-2	440	500	2.1	460	1.05	33.0	22.0	11.0	**50**	**150**	30

[1] PALs were developed to be protective of human health and the environment. Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs. Note that ESVs are only applicable to soil samples that are collected from less than 24-inches bgs; sources of ESVs are provided in Appendix F..

[2] PQL Goals are equal to half the minimum of the applicable criteria (PALs).

[3] DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

SAP Worksheet #15-2B—Reference Limits and Evaluation Table

Matrix: Sediment

Analytical Group: Pesticides

Analyte	CAS Number	Residential Soil RSL x 10 for Sediment, Adjusted[1] (µg/kg)	Sediment Eco SV[1] (µg/kg)	PQL Goal[2] (µg/kg)	Laboratory-Specific (µg/kg)			LCS, MS, and MSD %R and %RPD Limits[3]		
					LOQ	LOD	DL	LCL	UCL	RPD
4,4'-DDD	72-54-8	20000	1.22	0.61	0.670	0.340	0.170	30	135	30
4,4'-DDE	72-55-9	14000	2.2	1.1	0.670	0.340	0.170	70	125	30
4,4'-DDT	50-29-3	17000	1.19	0.595	0.670	0.340	0.170	45	140	30
Aldrin	309-00-2	290	9.5	4.75	0.670	0.340	0.110	45	140	30
alpha-BHC	319-84-6	770	1360	385	0.670	0.340	0.110	60	125	30
alpha-Chlordane	5103-71-9	16000	2.26	1.13	0.670	0.340	0.110	65	120	30
beta-BHC	319-85-7	2700	1360	680	0.670	0.340	0.110	60	125	30
delta-BHC	319-86-8	2700	1360	680	0.670	0.340	0.110	55	130	30
Dieldrin	60-57-1	300	0.72	0.36	0.670	0.340	0.170	65	125	30
Endosulfan I	959-98-8	370000	0.51	0.255	0.670	0.340	0.110	15	135	30
Endosulfan II	33213-65-9	370000	2.4	1.2	0.670	0.340	0.170	35	140	30
Endosulfan sulfate	1031-07-8	370000	0.36	0.18	0.670	0.340	0.170	60	135	30
Endrin	72-20-8	18000	3.5	1.75	0.670	0.340	0.170	60	135	30
Endrin aldehyde	7421-93-4	18000	3.5	1.75	0.670	0.340	0.170	35	145	30
Endrin ketone	53494-70-5	18000	3.5	1.75	0.670	0.340	0.170	65	135	30
gamma-BHC (Lindane)	58-89-9	5200	0.32	0.16	0.670	0.340	0.110	60	125	30
gamma-Chlordane	5103-74-2	16000	2.26	1.13	0.670	0.340	0.110	65	125	30
Heptachlor	76-44-8	1100	0.3	0.15	0.670	0.340	0.110	50	140	30
Heptachlor epoxide	1024-57-3	530	NC	265	0.670	0.340	0.110	65	130	30
Methoxychlor	72-43-5	310000	29.6	14.8	0.670	0.340	0.110	55	145	30
Toxaphene	8001-35-2	4400	540	270	33.0	22.0	11.0	**50**	**150**	30

[1] PALs were developed to be protective of human health and the environment. Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.

[2] PQL Goals are equal to half the minimum of the applicable criteria (PALs).

[3] DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

SAP Worksheet #15-3A—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: PCBs

Analyte	CAS Number	Residential Soil RSL (adjusted)[1] (µg/kg)	ESV[1] (µg/kg)	Risk-Based SSL[1] (µg/kg)	PQL Goal[2] (µg/kg)	Laboratory-Specific (µg/kg)			LCS, MS, and MSD %R and %RPD Limits[3]		
						LOQ	LOD	DL	LCL	UCL	RPD
Aroclor-1016	12674-11-2	390	8000	92	46	16.7	8.33	4.17	40	140	30
Aroclor-1221	11104-28-2	140	8000	0.074	0.037	16.7	8.33	4.17	NA	NA	NA
Aroclor-1232	11141-16-5	140	8000	0.074	0.037	16.7	8.33	4.17	NA	NA	NA
Aroclor-1242	53469-21-9	220	8000	5.3	2.65	16.7	8.33	4.17	NA	NA	NA
Aroclor-1248	12672-29-6	220	8000	5.2	2.6	16.7	8.33	4.17	NA	NA	NA
Aroclor-1254	11097-69-1	110	8000	8.8	4.4	16.7	8.33	4.17	NA	NA	NA
Aroclor-1260	11096-82-5	220	8000	24	12	16.7	8.33	4.17	60	130	30

[1] PALs were developed to be protective of human health and the environment. Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs. Note that ESVs are only applicable to soil samples that are collected from less than 24-inches bgs; sources of ESVs are provided in Appendix F.

[2] PQL Goals are equal to half the minimum of the applicable criteria (PALs).

[3] DoD QSM v.4.1 is the basis for LCS and MS/MSD limits.

Shading represents cases where the PAL or PQL goal is lower than the laboratory LOD.

NA indicates that these QC criteria are not applicable for these analytes, data quality is assessed by %R for Aroclor 1016 and 1260 only.

SAP Worksheet #15-3B—Reference Limits and Evaluation Table

Matrix: Sediment

Analytical Group: PCBs

Analyte	CAS Number	Residential Soil RSL x 10 for Sediment, Adjusted[1] (µg/kg)	Sediment Eco SV[1] (µg/kg)	PQL Goal[2] (µg/kg)	Laboratory-Specific (µg/kg)			LCS, MS, and MSD %R and %RPD Limits[3]		
					LOQ	LOD	DL	LCL	UCL	RPD
Aroclor-1016	12674-11-2	3900	48	24	16.7	8.33	4.17	40	140	30
Aroclor-1221	11104-28-2	1400	48	24	16.7	8.33	4.17	NA	NA	NA
Aroclor-1232	11141-16-5	1400	48	24	16.7	8.33	4.17	NA	NA	NA
Aroclor-1242	53469-21-9	2200	48	24	16.7	8.33	4.17	NA	NA	NA
Aroclor-1248	12672-29-6	2200	48	24	16.7	8.33	4.17	NA	NA	NA
Aroclor-1254	11097-69-1	1100	48	24	16.7	8.33	4.17	NA	NA	NA
Aroclor-1260	11096-82-5	2200	48	24	16.7	8.33	4.17	60	130	30

[1] PALs were developed to be protective of human health and the environment. Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.

[2] PQL Goals are equal to half the minimum of the applicable criteria (PALs).

[3] DoD QSM v.4.1 is the basis for LCS and MS/MSD limits.

Shading represents cases where the PAL or PQL goal is lower than the laboratory LOD.

NA indicates that these QC criteria are not applicable for these analytes, data quality is assessed by %R for Aroclor 1016 and 1260 only.

SAP Worksheet #15-4A—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: Explosives and Perchlorate

Analyte	CAS Number	Residential Soil RSL (adjusted)[1] (µg/kg)	ESV[1] (µg/kg)	Risk-Based SSL[1] (µg/kg)	PQL Goal[2,4] (µg/kg)	Laboratory-Specific (µg/kg)			LCS, MS, and MSD %R and %RPD Limits[3]		
						LOQ	LOD	DL	LCL	UCL	RPD
1,3,5-Trinitrobenzene (TNB)	99-35-4	220,000	NC	1700	850	80	40	20	75	125	30
1,3-Dinitrobenzene (DNB)	99-65-0	610	NC	1.4	0.7	80	40	20	80	125	30
2,4,6-TNT	118-96-7	3,600	10,000	13	6.5	80	40	20	55	140	30
2,4-Dinitrotoluene (DNT)	121-14-2	1,600	11,000	0.28	0.14	80	40	20	80	125	30
2,6-DNT)	606-20-2	6,100	8,500	20	10	80	40	20	80	120	30
2-Amino-4,6-dinitrotoluene (2-Am-DNT)	35572-78-2	15,000	80,000	23	11.5	80	40	20	80	125	30
2-Nitrotoluene (NT)	88-72-2	2,900	NC	0.25	0.125	80	40	20	80	125	30
3,5-Dinitroaniline	618-87-1	NC	NC	NC	Lab LOD	80	40	20	**60**	**120**	30
3-NT	99-08-1	610	NC	1.2	0.6	80	40	20	75	120	30
4-Amino-2,6-dinitrotoluene (4-Am-DNT)	19406-51-0	15,000	80,000	23	11.5	80	40	20	80	125	30
4-NT	99-99-0	24,000	NC	3.4	1.7	80	40	20	75	125	30
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	5,500	10,000	0.23	0.115	80	40	20	70	135	30
Tetryl	479-45-8	24,000	10,000	590	295	80	40	20	10	150	30
Nitrobenzene (NB)	98-95-3	4,800	2,260	0.079	0.0395	80	40	20	75	125	30
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	380,000	10,000	990	495	80	40	20	75	125	30
Perchlorate	14797-73-0	5,500	1,000	NC	500	20	10	5	80	120	15

[1] PALs were developed to be protective of human health and the environment. Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs. Note that ESVs are only applicable to soil samples that are collected from less than 24-inches bgs; sources of ESVs are provided in Appendix F.

[2] PQL Goals are equal to half the minimum of the applicable criteria (PALs).

[3] DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

[4] For HHRA the RSL for 3-NT will be used as a surrogate for 3,5-dinitroaniline.

NC indicates cases where there is no criteria for an analyte.

SAP Worksheet #15-4B—Reference Limits and Evaluation Table

Matrix: Sediment

Analytical Group: Explosives and Perchlorate

Analyte	CAS Number	Residential Soil RSL (adjusted) X 10 for SD[1] (µg/kg)	ESV[1] (µg/kg)	PQL Goal[2,4] (µg/kg)	Laboratory-Specific (µg/kg)			LCS, MS, and MSD %R and %RPD Limits[3]		
					LOQ	LOD	DL	LCL	UCL	RPD
1,3,5-TNB	99-35-4	2,200,000	7,000	3,500	80	40	20	75	125	30
1,3-DNB	99-65-0	6,100	NC	3,050	80	40	20	80	125	30
2,4,6-TNT	118-96-7	36,000	20,000	10,000	80	40	20	55	140	30
2,4-DNT	121-14-2	16,000	3,184	1,592	80	40	20	80	125	30
2,6-DNT	606-20-2	61,000	549	275	80	40	20	80	120	30
2-Am-DNT	35572-78-2	150,000	NC	75,000	80	40	20	80	125	30
2-NT	88-72-2	29,000	NC	14,500	80	40	20	80	125	30
3,5-Dinitroaniline	618-87-1	NC	NC	3,050	80	40	20	**60**	**120**	30
3-NT	99-08-1	6,100	NC	3,050	80	40	20	75	120	30
4-Am-DNT	19406-51-0	150,000	NC	75,000	80	40	20	80	125	30
4-NT	99-99-0	240,000	NC	120,000	80	40	20	75	125	30
RDX	121-82-4	56,000	891,000	27,500	80	40	20	70	135	30
Tetryl	479-45-8	240,000	72	36	80	40	20	10	150	30
NB	98-95-3	48,000	21	11	80	40	20	75	125	30
HMX	2691-41-0	3,800,000	115,000	57,500	80	40	20	75	125	30
Perchlorate	14797-73-0	55,000	NC	27,500	5	2	0.6	80	120	15

[1] PALs were developed to be protective of human health and the environment. Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs. The sources of the ESVs are provided in Appendix F.

[2] PQL Goals are equal to half the minimum of the applicable criteria (PALs).

[3] DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

[4] For HHRA the RSL for 3-NT will be used as a surrogate for 3,5-dinitroaniline.

Shading represents cases where the PAL or PQL goal is lower than the laboratory LOD.

NC indicates cases where there is no criteria for an analyte.

SAP Worksheet #15-5A—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: Metals/Cyanide

Analyte	CAS Number	Surface Soil Background Levels (milligram per kilogram [mg/kg])	Subsurface Soil Background Levels (mg/kg)	Residential Soil RSL (adjusted)[1] (mg/kg)	ESV[1] (mg/kg)	Risk-Based SSL[1] (mg/kg)	MCL-Based SSL[1] (mg/kg)	PQL Goal[2] (mg/kg)	Laboratory-Specific (mg/kg)			LCS, MS, and MSD %R and %RPD Limits[3]		
									LOQ	LOD	DL	LCL	UCL	RPD
Aluminum	7429-90-5	12,200	13,000	7,700	pH <5.5	23000	NC	3850	10	5	2.5	80	120	20
Antimony	7440-36-0	11	NC	3.1	78	0.27	0.27	0.135	0.5	0.4	0.25	80	120	20
Arsenic	7440-38-2	6.36	5.54	0.39	18	0.0013	0.29	0.00065	0.5	0.3	0.15	80	120	20
Barium	7440-39-3	52.9	84.5	1,500	330	120	82	26.45	2	0.5	0.25	80	120	20
Beryllium	7440-41-7	0.587	0.52	16	40	13	3.2	0.26	0.25	0.1	0.05	80	120	20
Cadmium	7440-43-9	1.5	NC	7	32	0.52	0.38	0.19	0.25	0.1	0.05	80	120	20
Calcium	7440-70-2	2,290	2,380	NC	NC	NC	NC	1145	250	100	50	80	120	20
Chromium	7440-47-3	18.2	33.7	0.29	64	0.00059	180000	0.000295	0.5	0.2	0.1	80	120	20
Cobalt	7440-48-4	9.93	5.18	2.3	13	0.21	NC	0.105	0.625	0.5	0.25	80	120	20
Copper	7440-50-8	4.25	3.17	310	70	22	46	1.585	0.5	0.4	0.2	80	120	20
Iron	7439-89-6	19,900	32,000	5,500	5 < pH > 8	0.094	2	0.047	5	3	1.5	80	120	20
Lead	7439-92-1	17.4	8.79	400	120	270	NC	4.395	0.15	0.15	0.075	80	120	20
Magnesium	7439-95-4	1,070	1,120	NC	NC	NC	14	7	250	150	50	80	120	20
Manganese	7439-96-5	324	176	180	220	NC	NC	88	0.75	0.3	0.15	80	120	20
Mercury	7439-97-6	0.111	0.14	2.3	0.1	21	NC	0.05	0.033	0.033	0.013	80	120	20
Nickel	7440-02-0	9.52	17.6	150	38	0.033	0.1	0.0165	0.5	0.3	0.15	80	120	20
Potassium	7440-09-7	708	901	NC	NC	20	NC	10	250	150	50	80	120	20

SAP Worksheet #15-5A—Reference Limits and Evaluation Table (continued)

Analyte	CAS Number	Surface Soil Background Levels (mg/kg)	Subsurface Soil Background Levels (mg/kg)	Residential Soil RSL (adjusted)[1] (mg/kg)	EEV[1] (mg/kg)	Risk-Based SSL[1] (mg/kg)	MCL-Based SSL[1] (mg/kg)	PQL Goal[2] (mg/kg)	Laboratory-Specific (mg/kg)			LCS, MS, and MSD %R and %RPD Limits[3]		
									LOQ	LOD	DL	LCL	UCL	RPD
Selenium	7782-49-2	0.51	0.64	39	0.52	0.4	0.26	0.13	0.5	0.25	0.15	80	120	20
Silver	7440-22-4	2.1	1.1	39	560	0.6	NC	0.3	0.5	0.1	0.05	80	120	20
Sodium	7440-23-5	521	811	NC	NC	NC	NC	260.5	250	150	50	80	120	20
Thallium	7440-28-0	NC	NC	0.078	1	0.011	0.14	0.0055	0.4	0.2	0.15	80	120	20
Vanadium	7440-62-2	27.9	48.3	39	130	78	NC	13.95	0.625	0.5	0.25	80	120	20
Zinc	7440-66-6	26.5	28	2,300	120	290	NC	13.25	1	0.5	0.25	80	120	20
Cyanide	57-12-5	NC	2.7	4.7	15.8	0.4	0.26	0.13	0.75	0.25	0.125	**80**	**120**	20

[1] PALs were developed to be protective of human health and the environment. Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs. Note that ESVs are only applicable to soil samples that are collected from less than 24-inches bgs; sources of ESVs are provided in Appendix F.

[2] PQL Goals are equal to half the minimum of the applicable criteria (PALs).

[3] DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

SAP Worksheet #15-5B—Reference Limits and Evaluation Table

Matrix: Sediment

Analytical Group: Metals/Cyanide

Analyte	CAS Number	Residential Soil RSL (adjusted) X 10 for SD[1] (mg/kg)	ESV[1] (mg/kg)	PQL Goal[2] (mg/kg)	Laboratory-Specific (mg/kg)			LCS, MS, and MSD %R and %RPD Limits[3]		
					LOQ	LOD	DL	LCL	UCL	RPD
Aluminum	7429-90-5	77,000	18,000	9000	10	5	2.5	80	120	20
Antimony	7440-36-0	31	2	1	0.5	0.4	0.25	80	120	20
Arsenic	7440-38-2	3.9	8.2	1.95	0.5	0.3	0.15	80	120	20
Barium	7440-39-3	15,000	48	24	2	0.5	0.25	80	120	20
Beryllium	7440-41-7	160	NC	80	0.25	0.1	0.05	80	120	20
Cadmium	7440-43-9	70	1.2	0.6	0.25	0.1	0.05	80	120	20
Calcium	7440-70-2	NC	NC	Lab LOD	250	100	50	80	120	20
Chromium	7440-47-3	2.9	81	1.45	0.5	0.2	0.1	80	120	20
Cobalt	7440-48-4	23	10	5	0.625	0.5	0.25	80	120	20
Copper	7440-50-8	3,100	34	17	0.5	0.4	0.2	80	120	20
Iron	7439-89-6	55,000	220,000	27500	5	3	1.5	80	120	20
Lead	7439-92-1	4,000	46.7	23.35	0.15	0.15	0.075	80	120	20
Magnesium	7439-95-4	NC	NC	Lab LOD	250	150	50	80	120	20
Manganese	7439-96-5	1,800	260	130	0.75	0.3	0.15	80	120	20
Mercury	7439-97-6	23	0.15	0.075	0.033	0.033	0.013	80	120	20
Nickel	7440-02-0	1,500	20.9	10.45	0.5	0.3	0.15	80	120	20
Potassium	7440-09-7	NC	NC	Lab LOD	250	150	50	80	120	20
Selenium	7782-49-2	390	1	0.5	0.5	0.25	0.15	80	120	20

SAP Worksheet #15-5B—Reference Limits and Evaluation Table (continued)

Analyte	CAS Number	Residential Soil RSL (adjusted) X 10 for SD[1] (mg/kg)	ESV[1] (mg/kg)	PQL Goal[2] (mg/kg)	Laboratory-Specific (mg/kg)			LCS, MS, and MSD %R and %RPD Limits[3]		
					LOQ	LOD	DL	LCL	UCL	RPD
Silver	7440-22-4	390	1	0.5	0.5	0.1	0.05	80	120	20
Sodium	7440-23-5	NC	NC	Lab LOD	250	150	50	80	120	20
Thallium	7440-28-0	0.78	NC	0.35	0.4	0.2	0.15	80	120	20
Vanadium	7440-62-2	390	57	28.5	0.625	0.5	0.25	80	120	20
Zinc	7440-66-6	23,000	150	75	1	0.5	0.25	80	120	20
Cyanide	57-12-5	47	NC	25	0.75	0.25	0.125	**80**	**120**	20

[1] PALs were developed to be protective of human health and the environment. Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs. The sources of the ESVs are provided in Appendix F.

[2] PQL Goals are equal to half the minimum of the applicable criteria (PALs).

[3] DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

SAP Worksheet #15-6A—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil and/or Sediment[1]

Analytical Group: Wet Chemistry

Analyte[2]	CAS Number[3]	Effect	Laboratory-Specific (mg/kg)		
			LOQ	LOD	DL
TOC	TOC	Used to determine the bioavailability of organic chemicals	800	400	200
pH	PH	Used to determine the bioavailability of certain metals.	0.1	0.1	0.1
GS03 Sieve 3" (75 millimeters [mm])	SIEVE75.0	Used to determine the nature of the substrate and how suitable it is as habitat for particular species; the distribution of particle sizes will also influence the bioavailability of some constituents.	NA	NA	NA
GS05 Sieve 2" (50 mm)	SIEVE50.0		NA	NA	NA
GS06 Sieve 1.5" (37.5 mm)	SIEVE37.5		NA	NA	NA
GS07 Sieve 1" (25.0 mm)	SIEVE25.0		NA	NA	NA
GS08 Sieve 0.75" (19.0 mm)	SIEVE19.0		NA	NA	NA
GS10 Sieve 0.375" (9.5 mm)	SIEVE9.5		NA	NA	NA
Sieve No. 004 (4.75 mm)	SIEVE4.75		NA	NA	NA
Sieve No. 010 (2.00 mm)	SIEVE2.0		NA	NA	NA
Sieve No. 020 (850 micrometers [µm])	SIEVE850		NA	NA	NA
Sieve No. 040 (425 µm)	SIEVE425		NA	NA	NA
Sieve No. 060 (250 µm)	SIEVE250		NA	NA	NA
Sieve No. 080 (180 µm)	SIEVE180		NA	NA	NA
Sieve No. 100 (150 µm)	SIEVE150		NA	NA	NA
Sieve No. 200 (75 µm)	SIEVE75		NA	NA	NA
Gravel (%)	GRAVEL		NA	NA	NA
			LOQ	**LOD**	**DL**
Coarse Sand (%)	COARSE SAND	Used to determine the nature of the substrate and how suitable it is as habitat for particular species; the distribution of particle sizes will also influence the bioavailability of some constituents.	NA	NA	NA
Medium Sand (%)	MEDIUM SAND		NA	NA	NA
Fine Sand (%)	FINE SAND		NA	NA	NA
Fines (%)	FINES		NA	NA	NA

[1] Only Sediment samples will undergo grain-size analysis.

[2] There are no applicable PALs for these analytes.

[3] These CAS Numbers are contractor-specific ID numbers.

SAP Worksheet #15-6B—Reference Limits and Evaluation Table

Matrix: Sediment

Analytical Group: AVS/SEM

Analyte[1]	CAS Number[2]	PIL (SEM/AVS ratio)	Effect	Laboratory-Specific (micromoles per gram [µmol]/g)		
				LOQ	LOD	DL
AVS	ACIDSO2	> 1	AVS/SEM results are provided as a ratio. SEM/AVS ratios >1 are interpreted to indicate that the metals evaluated are potentially bioavailable.	0.2	0.2	0.08
Cadmium	7440-43-9	> 1		0.0011	0.00044	0.00022
Copper	7440-50-8	> 1		0.0098	0.0031	0.002
Lead	7439-92-1	> 1		0.00036	0.00036	0.00018
Mercury	7439-97-6	> 1		0.000025	0.00001	0.00001
Nickel	7440-02-0	> 1		0.017	0.0026	0.0013
Silver	7440-22-4	> 1		0.0023	0.0012	0.0007
Zinc	7440-66-6	> 1		0.0076	0.0038	0.0019

[1] There are no applicable PALs for these analytes.

[2] The CAS Number for AVS is a contractor-specific ID number.

SAP Worksheet #15-7—Reference Limits and Evaluation Table

Matrix: Groundwater, Surface Water, Pore Water, Seep

Analytical Group: VOA

Analyte	CAS Number[4]	Residential Tapwater RSL (adjusted)[1] (micrograms per liter [µg/L])	Residential Tapwater RSL (adjusted) X 10 for SW[1] (µg/L)	ESV[1] (µg/L)	MCL[1] (µg/L)	PQL Goal[2] (µg/L)	Laboratory-Specific (µg/L)			LCS, MS, and MSD %R and %RPD Limits[3]		
							LOQ	LOD	DL	LCL	UCL	RPD
1,1,1-Trichloroethane	71-55-6	750	7500	312	200	100	1.00	0.50	0.25	65	130	30
1,1,2,2-Tetrachloroethane	79-34-5	0.066	0.66	90.2	NC	0.033	1.00	0.50	0.25	65	130	30
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	76-13-1	5300	53000	NC	NC	2650	2.00	1.00	0.50	**60**	**130**	30
1,1,2-Trichloroethane	79-00-5	0.041	0.41	550	5	0.0205	1.00	0.50	0.20	75	125	30
1,1-Dichloroethane	75-34-3	2.4	24	NC	NC	1.2	1.00	0.50	0.25	70	135	30
1,1-Dichloroethene	75-35-4	26	260	2,240	7	3.5	1.00	0.50	0.25	70	130	30
1,2,3-Trichlorobenzene	87-61-6	0.52	5.2	NC	NC	0.26	1.00	0.50	0.25	55	140	30
1,2,4-Trichlorobenzene	120-82-1	0.39	3.9	5.4	70	0.195	1.00	0.50	0.25	65	135	30
1,2-Dibromo-3-chloropropane	96-12-8	0.00032	0.0032	NC	0.2	0.00016	2.00	1.00	0.50	50	130	30
1,2-Dibromoethane	106-93-4	0.0065	0.065	NC	0.05	0.00325	1.00	0.50	0.25	80	120	30
1,2-DCB	95-50-1	37	370	42	600	18.5	1.00	0.50	0.25	70	120	30
1,2-Dichloroethane	107-06-2	0.15	1.5	1,130	5	0.075	1.00	0.50	0.16	70	130	30
1,2-Dichloropropane	78-87-5	0.38	38	2,400	5	0.19	1.00	0.50	0.25	75	125	30
1,3-DCB	541-73-1	NC	NC	28.5	NC	14.25	1.00	0.50	0.25	75	125	30
1,4-DCB	106-46-7	0.42	4.2	19.9	75	0.21	1.00	0.50	0.25	75	125	30
2-Butanone	78-93-3	490	4900	NC	NC	245	10.00	5.00	2.50	30	150	30

SAP Worksheet #15-7—Reference Limits and Evaluation Table (continued)

Analyte	CAS Number[4]	Residential Tapwater RSL (adjusted)[1] (µg/L)	Residential Tapwater RSL (adjusted) X 10 for SW[1] (µg/L)	ESV[1] (µg/L)	MCL[1] (µg/L)	PQL Goal[2] (µg/L)	Laboratory-Specific (µg/L)			LCS, MS, and MSD %R and %RPD Limits[3]		
							LOQ	LOD	DL	LCL	UCL	RPD
2-Hexanone	591-78-6	3.4	34	NC	NC	1.7	5.00	2.50	1.25	55	130	30
4-Methyl-2-pentanone	108-10-1	100	1000	123,000	NC	50	5.00	2.50	1.25	60	135	30
Acetone	67-64-1	1,200	12000	564,000	NC	600	10.00	5.00	2.50	40	140	30
Benzene	71-43-2	0.39	3.9	110	5	0.195	1.00	0.50	0.25	80	120	30
Bromochloromethane	74-97-5	8.3	83	NC	NC	4.15	1.00	0.50	0.25	65	130	30
Bromodichloromethane	75-27-4	0.12	1.2	NC	80	0.06	1.00	0.50	0.12	75	120	30
Bromoform	75-25-2	7.9	79	640	80	3.95	1.00	0.50	0.25	70	130	30
Bromomethane	74-83-9	0.7	7	120	NC	0.35	2.00	1.00	0.50	30	145	30
Carbon disulfide	75-15-0	72	720	NC	NC	36	1.00	0.50	0.25	35	160	30
Carbon tetrachloride	56-23-5	0.39	3.9	1,500	5	0.195	1.00	0.50	0.25	65	140	30
Chlorobenzene	108-90-7	7.2	72	25	100	3.6	1.00	0.50	0.25	80	120	30
Chloroethane	75-00-3	2,100	21,000	NC	NC	1050	2.00	1.00	0.50	60	135	30
Chloroform	67-66-3	0.19	1.9	815	80	0.095	1.00	0.50	0.17	65	135	30
Chloromethane	74-87-3	19	190	2,700	NC	9.5	1.00	0.50	0.25	40	125	30
cis-1,2-Dichloroethene	156-59-2	2.8	28	680	70	1.4	1.00	0.50	0.25	70	125	30
cis-1,3-Dichloropropene	10061-01-5	0.41	4.1	7.9	NC	0.205	1.00	0.50	0.25	70	130	30
Cyclohexane	110-82-7	1,300	13,000	NC	NC	650	1.00	0.50	0.25	**60**	**130**	30
Dibromochloromethane	124-48-1	0.15	1.5	NC	80	0.075	1.00	0.50	0.14	60	135	30
Dichlorodifluoromethane (Freon-12)	75-71-8	19	190	NC	NC	9.5	2.00	1.00	0.50	30	155	30

SAP Worksheet #15-7—Reference Limits and Evaluation Table (continued)

Analyte	CAS Number[4]	Residential Tapwater RSL (adjusted)[1] (µg/L)	Residential Tapwater RSL (adjusted) X 10 for SW[1] (µg/L)	ESV[1] (µg/L)	MCL[1] (µg/L)	PQL Goal[2] (µg/L)	Laboratory-Specific (µg/L)			LCS, MS, and MSD %R and %RPD Limits[3]		
							LOQ	**LOD**	**DL**	**LCL**	**UCL**	**RPD**
Ethylbenzene	100-41-4	1.3	13	25	700	0.65	1.00	0.50	0.25	75	125	30
Isopropylbenzene	98-82-8	39	390	NC	NC	19.5	1.00	0.50	0.25	75	125	30
m- and p-Xylene	m&pXYLENE	19	190	19	10000	9.5	2.00	1.00	0.50	75	130	30
Methyl acetate	79-20-9	1600	16000	NC	NC	800	2.00	1.00	0.50	**55**	**150**	30
Methylcyclohexane	108-87-2	NC	NC	NC	NC	Lab LOD	1.00	0.50	0.25	**60**	**125**	30
Methylene chloride	75-09-2	8.4	84	2,560	5	2.5	2.00	1.00	0.50	55	140	30
MTBE	1634-04-4	12	120	5,000	NC	6	1.00	0.50	0.25	65	125	30
o-Xylene	95-47-6	19	190	19	10000	9.5	1.00	0.50	0.25	80	120	30
Styrene	100-42-5	110	1100	910	100	50	1.00	0.50	0.25	65	135	30
Tetrachloroethene	127-18-4	3.5	35	45	5	1.75	1.00	0.50	0.13	45	150	30
Toluene	108-88-3	86	860	215	1000	43	1.00	0.50	0.25	75	120	30
trans-1,2-Dichloroethene	156-60-5	8.6	86	680	100	4.3	1.00	0.50	0.25	60	140	30
trans-1,3-Dichloropropene	10061-02-6	0.41	4.1	7.9	NC	0.205	1.00	0.50	0.25	55	140	30
Trichloroethene	79-01-6	0.26	2.6	1,940	5	0.13	1.00	0.50	0.25	70	125	30
Trichlorofluoromethane (Freon-11)	75-69-4	110	1100	NC	NC	55	2.00	1.00	0.50	60	145	30
Vinyl chloride	75-01-4	0.015	0.15	NC	2	0.0075	1.00	0.50	0.25	50	145	30

[1] PALs were developed to be protective of human health and the environment. Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs. The sources of the ESVs are provided in Appendix F

[2] PQL Goals are equal to half the minimum of the applicable criteria (PALs).

[3] DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

[4] The CAS Number for m- and p-xylenes is a contractor-specific ID number.

Shading represents cases where the PAL or PQL goal is lower than the laboratory LOD.

NC indicates cases where there is no criteria for an analyte.

SAP Worksheet #15-8—Reference Limits and Evaluation Table

Matrix: Groundwater
Analytical Group: Pesticides

Analyte	CAS Number	Residential Tapwater RSL (adjusted)[1] (µg/L)	ESV[1] (µg/L)	PQL Goal[2] (µg/L)	Laboratory-Specific (µg/L)			LCS, MS, and MSD %R and %RPD Limits[3]		
					LOQ	LOD	DL	LCL	UCL	RPD
4,4'-DDD	72-54-8	0.28	0.025	0.0125	0.004	0.002	0.001	25	150	30
4,4'-DDE	72-55-9	0.2	0.14	0.07	0.004	0.002	0.001	35	140	30
4,4'-DDT	50-29-3	0.2	0.0065	0.00325	0.004	0.002	0.001	45	140	30
Aldrin	309-00-2	0.00021	0.13	0.0001	0.004	0.002	0.00066	25	140	30
alpha-BHC	319-84-6	0.0062	25	0.0031	0.004	0.002	0.00066	60	130	30
alpha-Chlordane	5103-71-9	0.027	0.004	0.0135	0.004	0.002	0.00066	65	125	30
beta-BHC	319-85-7	0.022	25	0.011	0.004	0.002	0.00066	65	125	30
delta-BHC	319-86-8	0.022	25	0.011	0.004	0.002	0.00066	45	135	30
Dieldrin	60-57-1	0.0015	0.11	0.00075	0.004	0.002	0.001	60	130	30
Endosulfan I	959-98-8	7.8	0.0087	3.9	0.004	0.002	0.00066	50	110	30
Endosulfan II	33213-65-9	7.8	0.0087	3.9	0.004	0.002	0.001	30	130	30
Endosulfan sulfate	1031-07-8	7.8	0.0087	3.9	0.004	0.002	0.001	55	155	30
Endrin	72-20-8	0.17	0.01	0.085	0.004	0.002	0.001	55	135	30
Endrin aldehyde	7421-93-4	0.17	0.01	0.085	0.004	0.002	0.001	55	135	30
Endrin ketone	53494-70-5	0.17	0.01	0.085	0.004	0.002	0.001	75	125	30
gamma-BHC (Lindane)	58-89-9	0.036	0.016	0.018	0.004	0.002	0.00066	25	135	30
gamma-Chlordane	5103-74-2	0.027	0.004	0.0135	0.004	0.002	0.00066	60	125	30
Heptachlor	76-44-8	0.0018	0.0036	0.0009	0.004	0.002	0.00066	40	130	30
Heptachlor epoxide	1024-57-3	0.0033	0.0036	0.00165	0.004	0.002	0.00066	60	130	30
Methoxychlor	72-43-5	2.7	0.03	1.35	0.004	0.002	0.00066	55	150	30
Toxaphene	8001-35-2	0.013	0.21	0.0065	0.2	0.1334	0.066	**50**	**150**	30

[1] PALs were developed to be protective of human health and the environment. Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs. The sources of the ESVs are provided in Appendix F.

[2] PQL Goals are equal to half the minimum of the applicable criteria (PALs).

[3] DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

Shading represents cases where the PAL or PQL goal is lower than the laboratory LOD.

NC indicates cases where there is no criteria for an analyte.

SAP Worksheet #15-9—Reference Limits and Evaluation Table

Matrix: Groundwater

Analytical Group: PCBs

Analyte	CAS Number	Residential Tapwater RSL (adjusted)[1] (µg/L)	ESV[1] (µg/L)	PQL Goal[2] (µg/L)	Laboratory-Specific (µg/L)			LCS, MS, and MSD %R and %RPD Limits[3]		
					LOQ	LOD	DL	LCL	UCL	RPD
Aroclor-1016	12674-11-2	0.11	0.03	0.015	0.1	0.05	0.025	40	140	30
Aroclor-1221	11104-28-2	0.0043	0.03	0.002	0.1	0.05	0.025	NA	NA	NA
Aroclor-1232	11141-16-5	0.0043	0.03	0.001	0.1	0.05	0.025	NA	NA	NA
Aroclor-1242	53469-21-9	0.034	0.03	0.015	0.1	0.05	0.025	NA	NA	NA
Aroclor-1248	12672-29-6	0.034	0.03	0.015	0.1	0.05	0.025	NA	NA	NA
Aroclor-1254	11097-69-1	0.031	0.03	0.015	0.1	0.05	0.025	NA	NA	NA
Aroclor-1260	11096-82-5	0.034	0.03	0.015	0.1	0.05	0.025	60	130	30

[1] PALs were developed to be protective of human health and the environment. Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs. The sources of the ESVs are provided in Appendix F.

[2] PQL Goals are equal to half the minimum of the applicable criteria (PALs).

[3] DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

Shading represents cases where the PAL or PQL goal is lower than the laboratory LOD. Refer to **Worksheet # 11** for information on how data will be used in these instances.

NC indicates cases where there is no criteria for an analyte.

NA indicates that these QC criteria are not applicable for these analytes, data quality is assessed by %R for Aroclor 1016 and 1260 only.

SAP Worksheet #15-10—Reference Limits and Evaluation Table

Matrix: Groundwater, Surface Water, Pore Water, Seep

Analytical Group: Explosives and Perchlorate

Analyte	CAS Number	Residential Tapwater RSL (adjusted)[1] (µg/L)	Residential Tapwater RSL (adjusted) X 10 for SW[1] (µg/L)	ESV[1] (µg/L)	PQL Goal[2,4] (µg/L)	Laboratory-Specific (µg/L)			LCS, MS, and MSD %R and %RPD Limits[3]		
						LOQ	LOD	DL	LCL	UCL	RPD
1,3,5-TNB	99-35-4	46	460	15	7.5	0.32	0.16	0.08	65	140	30
1,3-DNB	99-65-0	0.15	1.5	180	0.075	0.32	0.16	0.08	45	160	30
2,4,6-TNT	118-96-7	0.76	7.6	100	0.38	0.32	0.16	0.08	50	145	30
2,4-2,4-DNT	121-14-2	0.2	2	480	0.1	0.32	0.16	0.08	60	135	30
2,6-2,6-DNT	606-20-2	1.5	15	1,000	0.75	0.32	0.16	0.08	60	135	30
2-Am-DNT	35572-78-2	3	30	NC	1.5	0.32	0.16	0.08	50	155	30
2-NT	88-72-2	0.27	2.7	NC	0.135	0.32	0.16	0.08	45	135	30
3,5-Dinitroaniline	618-87-1	NC	NC	NC	Lab LOD	0.32	0.16	0.08	**60**	**120**	30
3-NT	99-08-1	0.13	1.3	NC	0.065	0.32	0.16	0.08	50	130	30
4-Am-DNT	19406-51-0	3	30	NC	1.5	0.32	0.16	0.08	55	155	30
4-NT	99-99-0	3.7	37	NC	1.85	0.32	0.16	0.08	50	130	30
RDX	121-82-4	0.61	6.1	5,000	0.305	0.32	0.16	0.08	50	160	30
Tetryl	479-45-8	6.3	63	8	3.15	0.32	0.16	0.08	20	175	30
NB	98-95-3	0.12	1.2	66.8	0.06	0.32	0.16	0.08	50	140	30
HMX	2691-41-0	78	780	NC	39	0.32	0.16	0.08	80	115	30
Perchlorate	14797-73-0	1.1	11	NC	0.55	0.5	0.2	0.066	80	120	15

[1] PALs were developed to be protective of human health and the environment. Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs. The sources of the ESVs are provided in Appendix F.

[2] PQL Goals are equal to half the minimum of the applicable criteria (PALs).

[3] DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

[4] For HHRA the RSL for 3-NT will be used as a surrogate for 3,5-dinitroaniline.

Shading represents cases where the PAL or PQL goal is lower than the laboratory LOD.

NC indicates cases where there is no criteria for an analyte.

SAP Worksheet #15-11—Reference Limits and Evaluation Table

Matrix: Groundwater, Surface Water, Pore Water, Seep

Analytical Group: Total Metals/Cyanide and Dissolved Metals

Analyte	CAS Number	Total Metals Background[1] (µg/L)	Filtered Metals Background[1] (µg/L)	Residential Tapwater RSL (adjusted)[1] (µg/L)	Residential Tapwater RSL (adjusted) X 10 for SW[1] (µg/L)	Total ESV[1] (µg/L)	Dissolved ESV[1] (µg/L)	MCL[1] (µg/L)	PQL Goal[2] (µg/L)	Laboratory-Specific (µg/L)			LCS, MS, and MSD %R and %RPD Limits[3]		
										LOQ	LOD	DL	LCL	UCL	RPD
Aluminum	7429-90-5	2,230	100	1600	16000	NC	NC	NC	50	50	25	12.5	80	120	20
Antimony	7440-36-0	18.8	9.7	0.6	6	500	500	6	0.3	2.5	2	1.25	80	120	20
Arsenic	7440-38-2	2.28	1.37	0.045	0.45	36	36	10	0.0225	2.5	1.5	0.75	80	120	20
Barium	7440-39-3	118	127	290	2900	200	200	2,000	59	10	2.5	1.25	80	120	20
Beryllium	7440-41-7	2.45	NC	1.6	16	100	100	4	0.8	1.25	0.5	0.25	80	120	20
Cadmium	7440-43-9	0.605	0.177	0.69	6.9	8.85	8.80	5	0.0885	1.25	0.5	0.25	80	120	20
Calcium	7440-70-2	169,000	113,000	NC	NC	NC	NC	NC	56500	1250	500	250	80	120	20
Chromium	7440-47-3	15.1	6.04	0.031	0.31	50.4	50.0	100	0.0155	2.5	1	0.5	80	120	20
Cobalt	7440-48-4	20.6	0.7	0.47	4.7	NC	NC	NC	0.235	3.125	2.5	1.25	80	120	20
Copper	7440-50-8	12.2	3	62	620	3.73	3.10	1,300	1.5	2.5	2	1	80	120	20
Iron	7439-89-6	894	275	1100	11000	NC	NC	NC	137.5	25	15	7.5	80	120	20
Lead	7439-92-1	21.3	1.7	15	150	8.52	8.10	15	0.85	0.75	0.75	0.375	80	120	20
Magnesium	7439-95-4	11,500	11,200	NC	NC	NC	NC	NC	5600	1250	750	250	80	120	20
Manganese	7439-96-5	57.9	49.5	32	320	100	100	NC	16	3.75	1.5	0.75	80	120	20
Mercury	7439-97-6	0.081	0.1	0.43	4.3	1.11	0.94	2	0.0405	0.2	0.2	0.08	80	120	20
Nickel	7440-02-0	11.4	12.2	30	300	8.28	8.20	NC	4.1	2.5	1.5	0.75	80	120	20
Potassium	7440-09-7	12,700	12,600	NC	NC	NC	NC	NC	6300	1250	750	250	80	120	20
Selenium	7782-49-2	NC	9.1	7.8	78	71.1	71.0	50	3.9	2.5	1.25	0.75	80	120	20
Silver	7440-22-4	NC	NC	7.1	71	0.23	0.23	NC	0.115	2.5	0.5	0.25	80	120	20
Sodium	7440-23-5	64,500	62,800	NC	NC	NC	NC	NC	31400	1250	750	250	80	120	20
Thallium	7440-28-0	NC	NC	NC	NC	21.3	21.3	2	1	2	1	0.75	80	120	20
Vanadium	7440-62-2	26.2	4.3	7.8	78	50	50	NC	2.15	3.125	2.5	1.25	80	120	20
Zinc	7440-66-6	4.52	NC	470	4700	85.6	81	NC	2.26	5	2.5	1.25	80	120	20
Cyanide[4]	57-12-5	NC	NC	0.93	9.3	1	NC	200	0.5	20	10	5	**80**	**120**	20

[1] PALs were developed to be protective of human health and the environment. Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs. The sources of the ESVs are provided in Appendix F.

[2] PQL Goals are equal to half the minimum of the applicable criteria (PALs).

[3] DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

[4] Filtered samples will not be tested for Cyanide.

Shading represents cases where the PAL or PQL goal is lower than the laboratory LOD.

NC indicates cases where there is no criteria for an analyte.

SAP Worksheet #15-12—Reference Limits and Evaluation Table

Matrix: Groundwater

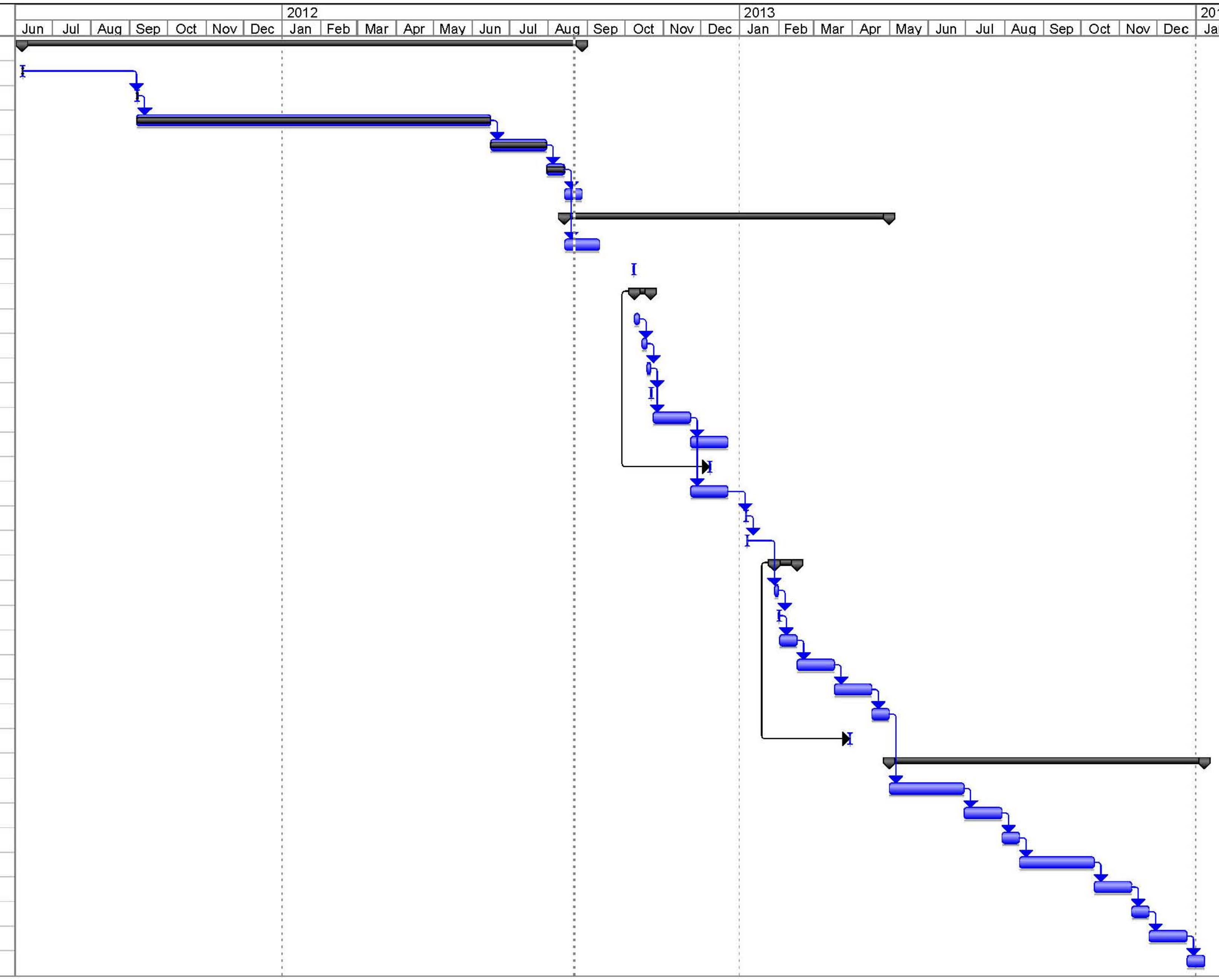
Analytical Group: Wet Chemistry

Analyte	CAS Number[3]	Project Indicator Level[1] (mg/L)	Effect	PQL Goal[2] (mg/L)	Laboratory-Specific (mg/L)		
					LOQ	LOD	DL
Chloride[4]	16887-00-6	NC	NA	Lab LOQ	0.5	0.33	0.17
Nitrate[4]	14797-55-8	NC	NA	Lab LOQ	0.2	0.1	0.033
Nitrite[4]	14797-65-0	NC	NA	Lab LOQ	0.2	0.1	0.033
Sulfate	14808-79-8	20	If sulfur compounds are present in the aquifer, higher concentrations of sulfate may compete with the reductive dechlorination pathway. Therefore, ideal conditions will maintain low sulfate levels.	10	2	1	0.33
Sulfide	18496-25-8	1	If sulfur compounds are present in the aquifer, higher concentrations of sulfide are more favorable to reductive dechlorination. Therefore, ideal conditions will maintain higher sulfide levels.	0.5	4	2	0.8
TOC	TOC	20	TOC is an indicator of the total amount of organic matter available to microbial communities to use as a carbon source in the degradation of VOCs. Increasing TOC concentrations are a positive indicator of natural attenuation potential.	10	1	0.5	0.25
Alkalinity	471-34-1	50	A measurement of the available buffering capacity against pH change, which can affect the rate of degradation of chemicals. Decreasing alkalinity may indicate that pH conditions are becoming less optimal for reductive dechlorination.	25	1	1	1
Ferrous Iron	FERROUS	1	Elevated concentrations indicate the activity of iron-reducing bacteria and are a positive indication that reductive dechlorination of VOCs may be occurring.	0.5	0.06	0.06	0.02
Methane	74-82-8	0.5	Elevated methane levels are expected to be seen under highly reducing conditions as a byproduct of degradation by methanogenic bacteria and are a positive indicator that degradation of VOCs and some explosives can occur.	0.25	4	2	1

[1] PILs for groundwater were established to assist with determining if natural attenuation is occurring at the site. Refer to **Worksheets #10 and #11** for a discussion on development of PILs.
[2] PQL Goals are equal to half the minimum of the applicable criteria (PILs).
[3] The CAS Number for TOC and Ferrous Iron are contractor-specific ID numbers.
[4] These data are being collected to provide baseline data for a trend analysis in the event that a remedy involving natural or enhanced attenuation is determined to be a possibility.
Shading represents cases where the PIL or PQL goal is lower than the laboratory LOD.
NC indicates cases where there is no criteria for an analyte.
NA indicates that this is not applicable.

SAP Worksheet #16—Project Schedule /Timeline Table

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Site 7 SAP and HASP Preparation (CTO WE29)**	**448 days**	**Tue 6/7/11**	**Mon 8/27/12**	
2	Pre-Draft SAP to Navy	1 day	Tue 6/7/11	Tue 6/7/11	
3	Draft SAP to Team	1 day	Wed 9/7/11	Wed 9/7/11	2
4	Resolution of Team comments	283 days	Wed 9/7/11	Fri 6/15/12	3
5	Draft Final SAP to Team	45 days	Sat 6/16/12	Mon 7/30/12	4
6	Team Concensus on SAP	14 days	Tue 7/31/12	Mon 8/13/12	5
7	Final SAP	14 days	Tue 8/14/12	Mon 8/27/12	6
8	**Site 7 Investigation Activities**	**260 days**	**Tue 8/14/12**	**Tue 4/30/13**	
9	Subcontractor Procurement	28 days	Tue 8/14/12	Mon 9/10/12	6
10	Utility Locating	1 day	Mon 10/8/12	Mon 10/8/12	
11	**Mob 1**	**13 days**	**Tue 10/9/12**	**Sun 10/21/12**	
12	Sample 40 SS/SB + 4 outfall SD	4 days	Tue 10/9/12	Fri 10/12/12	
13	Install 7 wells	4 days	Mon 10/15/12	Thu 10/18/12	12
14	Sample 11 wells	3 days	Fri 10/19/12	Sun 10/21/12	13
15	Land Surveying	1 day	Mon 10/22/12	Mon 10/22/12	14
16	Sampling Laboratory Analysis	30 days	Wed 10/24/12	Thu 11/22/12	14FS+2 days
17	Data Validation	30 days	Fri 11/23/12	Sat 12/22/12	16
18	IDW Removal	1 day	Sat 12/8/12	Sat 12/8/12	11SS+60 days
19	Raw Data Tables Provided to Team	30 days	Fri 11/23/12	Sat 12/22/12	16
20	Team Site Visit/Review Raw Data	1 day	Sun 1/6/13	Sun 1/6/13	19FS+14 days
21	Team Resolution Path Forward	1 day	Mon 1/7/13	Mon 1/7/13	20
22	**Mob 2**	**18 days**	**Tue 1/29/13**	**Fri 2/15/13**	
23	Sample 11 wells	3 days	Tue 1/29/13	Thu 1/31/13	21FS+21 days
24	Sample 8 SW/SD	1 day	Fri 2/1/13	Fri 2/1/13	23
25	Sample 8 pore water/seep	14 days	Sat 2/2/13	Fri 2/15/13	24
26	Sampling Laboratory Analysis	30 days	Sat 2/16/13	Sun 3/17/13	25
27	Data Validation	30 days	Mon 3/18/13	Tue 4/16/13	26
28	Data Management	14 days	Wed 4/17/13	Tue 4/30/13	27
29	IDW Removal	1 day	Sat 3/30/13	Sat 3/30/13	22SS+60 days
30	**Site 7 RI Reporting**	**252 days**	**Wed 5/1/13**	**Tue 1/7/14**	
31	Preliminary SI Report	60 days	Wed 5/1/13	Sat 6/29/13	28
32	Navy Review	30 days	Sun 6/30/13	Mon 7/29/13	31
33	Draft SI Report	14 days	Tue 7/30/13	Mon 8/12/13	32
34	Team Review	60 days	Tue 8/13/13	Fri 10/11/13	33
35	Comment Resolution	30 days	Sat 10/12/13	Sun 11/10/13	34
36	Draft Final SI Report	14 days	Mon 11/11/13	Sun 11/24/13	35
37	Team Consensus on SI	30 days	Mon 11/25/13	Tue 12/24/13	36
38	Final SI Report	14 days	Wed 12/25/13	Tue 1/7/14	37



BLUE TEXT - WORK ON OTHER CTOs
Date: Tue 8/21/12

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

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SAP Worksheet #17—Sampling Design and Rationale

Sampling Rationale

This investigation will be conducted in a phased approach, consistent with the CERCLA process and agreed upon by the Partnering Team. Two rounds of sampling will occur as part of this investigation. In the first sampling event, soil, sediment outfall, and groundwater samples will be collected and analyzed. Risk screening will be conducted on the soil, sediment outfall, and groundwater sampling results from the first sampling event to support decisions on the placement of, and analytes for, surface water and sediment samples, and for the pore water and seep samples (if determined necessary) during the second sampling event. If soil, sediment outfall, and groundwater sample results indicate a potential risk to receptors, then pore water and seep samples will be collected as part of the second sampling event. The locations of the surface water, sediment, pore water, and seep samples collected during the second sampling event will be agreed upon by the Partnering Team with input from the ecological technical support. In addition, if pore water and seep samples are determined to be necessary, an additional round of groundwater samples will be collected concurrent with the surface water and sediment sampling. All analytical data collected as part of this investigation will be evaluated quantitatively in the human health and ERAs, with the exception of the groundwater data which will be evaluated qualitatively in support of the aquatic ERA.

Soil, sediment outfall, and groundwater samples from the first sampling event will be evaluated using multiple lines of evidence, including background sample results, SSLs, RSLs, and ESVs. Particular emphasis will be placed on identification of potential source areas and evaluating potential downgradient transport pathways to the wetland area adjacent to Felgates Creek.

Surface and Subsurface Soil

Surface and subsurface soil samples will be collected during the first sampling event. Surface and subsurface soil sample locations (**Figure 4**) were chosen within the former building footprints, associated conveyor areas, and most likely loading/unloading zones in the vicinity of the former building footprints. Soil sample locations selected downgradient of the former building footprints were established by identifying the most likely potential release points and contaminant accumulation areas based on the site history and surface topography. The samples downgradient of the former building footprints will be used to evaluate surface runoff and soil deposition that may have occurred during plant operation or as a result of the building demolition. In addition, one sample will be collected from the most upgradient point of the remediated drainage area, to confirm if surface runoff or building demolition has resulted in recontamination of the previously remediated drainage area. The rationale for each individual surface and subsurface soil sample location is explained in detail in **Appendix G**.

Sediment Outfall

Sediment outfall samples will be collected during the first sampling event. Sediment outfall sample locations will be collected from four of the downgradient outfall locations (**Figure 4**) identified from the base Stormwater Pollution Prevention Plan (SWPPP). A field visit confirmed that the majority of drop inlets identified were removed or buried during building demolition, and are therefore inaccessible. The sediment outfall sample will be collected from the first depositional area downgradient of the downgradient outfall locations identified in the SWPPP. The first depositional area will be determined in

SAP Worksheet #17—Sampling Design and Rationale (continued)

the field and in most cases would be in the floodplain of the tributary to Felgates Creek, and may be ten or more feet away from the actual pipe. Approximate locations of the sediment outfall samples are shown in **Figure 4**. The outfall location identified as NR-017 will not be sampled, as there are no drainage features that connect Site 7 to this drainage feature. The rationale for each sediment outfall sample is explained in detail in **Appendix G**.

Groundwater

The new groundwater monitoring well locations were determined based on historical sampling data and site history. Each of the seven newly installed groundwater monitoring wells, and four existing groundwater monitoring wells will be sampled (**Figure 4**) during the first sampling event. Existing groundwater monitoring well 7GW04, will not be sampled because it is not in the vicinity of the site and does not truly represent upgradient conditions due to its location. Additional groundwater samples will potentially be collected during the second sampling event, if pore water and seep samples are determined to be necessary based on the results of the first sampling event.

Surface Water and Sediment

Surface water and sediment samples will be collected during the second sampling event from Felgates Creek or its tributaries, at locations to be determined based on the results of the soil, sediment outfall, and groundwater samples collected during the first sampling event. Sample locations will be determined based on previous sample results, surface topography, and site history. Surface water/ sediment locations will be co-located and will be collected from depositional areas.

Pore Water and Seep

Pore water and seep samples will be collected during the second sampling event, if results from the soil, sediment outfall, and groundwater samples collected during the first sampling event indicate a potential risk through that pathway. Locations of pore water and seep samples, if determined necessary, will be selected based on previous sample results and the results of the Seep Survey conducted in May 2011. An additional seep survey may be conducted prior to sampling, during the spring months, if determined to be necessary by the team.

SAP Worksheet #17—Sampling Design and Rationale (continued)

Matrix	Depths to Sample	Analysis	Method	Number of Samples	Rationale	* Sampling Strategy
Site 07						
First Sampling Event						
Surface Soil – Conveyor Area	0-6 inches	VOCs, explosives, perchlorate, 3,5-dinitroaniline, metals, pesticides/PCBs, pH, and TOC	SW-846 8260C SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A SW-846 9045D Lloyd Kahn	11	Samples will be collected in the vicinity of the former Plant 3 buildings and the conveyors between the buildings to determine if operations in this area contaminated surrounding soil	Eleven samples will be collected along the linear pathway of the former conveyors between buildings 502,503, 504, 505, and 375
Subsurface Soil – Conveyor Area	6-24 inches	VOCs, explosives, perchlorate, 3,5-dinitroaniline, metals, pesticides/PCBs, pH, and TOC	SW-846 8260C SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A SW-846 9045D Lloyd Kahn	11	Samples will be collected in the vicinity of the former Plant 3 buildings and the conveyors between the buildings to determine if operations in this area contaminated surrounding soil	Eleven samples will be collected along the linear pathway of the former conveyors between buildings 502, 503, 504, 505, and 375
Surface Soil – Former Building Footprints	0-6 inches	VOCs, explosives, perchlorate, 3,5-dinitroaniline, metals, pesticides/PCBs, pH, and TOC	SW-846 8260C SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A SW-846 9045D Lloyd Kahn	14	Samples will be collected within the former building footprints to determine if a release has occurred as a result of building demolition	Fourteen samples will be collected within the former building footprints of buildings 502, 504, 504, 505, and 375

SAP Worksheet #17—Sampling Design and Rationale (continued)

Matrix	Depths to Sample	Analysis	Method	Number of Samples	Rationale	* Sampling Strategy
Subsurface Soil – Former Building Footprints	6-24 inches	VOCs, explosives, perchlorate, 3,5-dinitroaniline, metals, pesticides/PCBs, pH, and TOC	SW-846 8260C SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A SW-846 9045D Lloyd Kahn	14	Samples will be collected within the former building footprints to determine if a release has occurred as a result of building demolition	Fourteen samples will be collected within the former building footprints of buildings 502, 504, 504, 505, and 375. .
Surface soil – Loading/ Unloading Zones	0-6 inches	VOCs, explosives, perchlorate, 3,5-dinitroaniline, metals, pesticides/PCBs, pH, and TOC	SW-846 8260C SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A SW-846 9045D Lloyd Kahn	6	Samples will be collected in the vicinity of former doorways to evaluate the potential for contamination resulting from loading/unloading operations	Samples will be collected from the most likely loading/unloading zones associated with operations in buildings 502, 503, 504, and 505
Subsurface soil – Loading/ Unloading Zones	6-24 inches	VOCs, explosives, perchlorate, 3,5-dinitroaniline, metals, pesticides/PCBs, pH, and TOC	SW-846 8260C SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A SW-846 9045D Lloyd Kahn	6	Samples will be collected in the vicinity of former doorways to evaluate the potential for contamination resulting from loading/unloading operations	Samples will be collected from the most likely loading/unloading zones associated with operations in buildings 502, 503, 504, and 505
Surface soil – Downgradient Area	0-6 inches	VOCs, explosives, perchlorate, 3,5-dinitroaniline, metals, pesticides/PCBs, pH, and TOC	SW-846 8260C SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A SW-846 9045D Lloyd Kahn	7	Samples will be collected in depositional areas to evaluate surface runoff and soil deposition that may have occurred during plant operations or as a result of building demolition from the upgradient former buildings	Samples will be collected from areas downgradient of the former building footprints and conveyor area

SAP Worksheet #17—Sampling Design and Rationale (continued)

Matrix	Depths to Sample	Analysis	Method	Number of Samples	Rationale	* Sampling Strategy
Subsurface soil – Downgradient Area	6-24 inches	VOCs, explosives, perchlorate, 3,5-dinitroaniline, metals, pesticides/PCBs, pH, and TOC	SW-846 8260C SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A SW-846 9045D Lloyd Kahn	7	Samples will be collected in depositional areas to evaluate surface runoff and soil deposition that may have occurred during plant operations or as a result of building demolition from the upgradient former buildings	Samples will be collected from areas downgradient of the former building footprints and conveyor area
Surface soil – Remediated Discharge Area	0-6 inches	VOCs, explosives, perchlorate, 3,5-dinitroaniline, metals, pesticides/PCBs, pH, and TOC	SW-846 8260C SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A SW-846 9045D Lloyd Kahn	1	One sample will be collected to evaluate the previously remediated discharge area and determine if surface runoff and building demolition resulted in any recontamination	A sample will be collected from the most upgradient point of the remediated drainage area to confirm surface runoff and building demolition did not result in recontamination
Subsurface soil – Remediated Discharge Area	6-24 inches	VOCs, explosives, perchlorate, 3,5-dinitroaniline, metals, pesticides/PCBs, pH, and TOC	SW-846 8260C SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A SW-846 9045D Lloyd Kahn	1	One sample will be collected to evaluate the previously remediated discharge area and determine if building demolition resulted in any recontamination	A sample will be collected from the most upgradient point of the remediated drainage area to confirm surface runoff and building demolition did not result in recontamination
Surface soil – Discharge Pipe	0-6 inches	VOCs, explosives, perchlorate, 3,5-dinitroaniline, metals, pesticides/PCBs, pH, and TOC	SW-846 8260C SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A SW-846 9045D Lloyd Kahn	1	One sample will be collected to evaluate the discharge location south of former Buildings 504 and 505	A sample will be collected at the base of the corrugated metal pipe extending from the base of the soil berm that connects the concrete drainage feature located south of the buildings

SAP Worksheet #17—Sampling Design and Rationale (continued)

Matrix	Depths to Sample	Analysis	Method	Number of Samples	Rationale	* Sampling Strategy
Subsurface soil – Discharge Pipe	6-24 inches	VOCs, explosives, perchlorate, 3,5-dinitroaniline, metals, pesticides/PCBs, pH, and TOC	SW-846 8260C SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A SW-846 9045D Lloyd Kahn	1	One sample will be collected to evaluate the discharge location south of former Buildings 504 and 505	A sample will be collected at the base of the corrugated metal pipe extending from the base of the soil berm that connects the concrete drainage feature located south of the buildings
Sediment – Outfall Locations	0-4 inches	VOCs, explosives, perchlorate, 3,5-dinitroaniline, metals, pesticides/PCBs, pH, and TOC	SW-846 8260C SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A SW-846 9045D Lloyd Kahn	4	Samples will be collected to evaluate soil/sediment characteristics at 4 downgradient outfall locations	Samples will be collected from each outfall location, at the first depositional area downgradient from each outfall
Groundwater	Middle of screen	VOCs, explosives, perchlorate, 3,5-dinitroaniline, metals, pesticide/PCBs, pH, TOC, chloride, nitrate, nitrite, sulfate, sulfide, TOC, alkalinity, ferrous iron and methane.	SW-846 8260C SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A EPA 300.0 SM4500-S2-F SW-846 9060 SM2023B SM3500-Fe-D RSK175 Lloyd Kahn	11 (7 new and 4 existing)	Sample will be collected to determine if contaminants are present in groundwater and if natural attenuation is occurring	Four samples will be collected from new wells in the vicinity of the conveyors and former building footprints, one sample will be collected from between Bldgs 504 and 505. Two samples will be collected from wells upgradient of the site and four samples will be collected from existing wells across the site (all existing wells with the exception of 7GW04).

SAP Worksheet #17—Sampling Design and Rationale (continued)

Matrix	Depths to Sample	Analysis	Method	Number of Samples	Rationale	* Sampling Strategy
Second Sampling Event						
Sediment	0-4 inches	Contaminants which exceeded background and RSLs and/or ESVs in primary conveyor area soil samples	SW-846 8260C and/or any of: SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A SW-846 9045D Lloyd Kahn	Minimum of 8	Samples will be collected to determine if contaminants have migrated to sediment	Locations will be collected based on team evaluation of transport pathways following receipt of soil, sediment outfall, and groundwater samples. Locations will be selected using multiple lines of evidence, including likely contaminant transport pathways
Surface water	NA	Contaminants which exceeded background and RSLs and/or ESVs in primary conveyor area soil samples	SW-846 8260C and/or any of: SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A SW-846 9045D Lloyd Kahn	Minimum of 8	Samples will be collected to determine if contaminants have migrated to surface water	Locations will be collected based on team evaluation of transport pathways following receipt of soil, sediment outfall, and groundwater samples
Seeps/Pore water	NA	Contaminants which exceeded background and RSLs and/or ESVs in primary conveyor area soil samples	SW-846 8260C and/or any of: SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A SW-846 9045D Lloyd Kahn	Up to 8 of each	Samples will be collected to evaluate the potential transport pathway from groundwater to surface water	Locations will be selected based on team evaluation of transport pathways following receipt of soil, sediment outfall, and groundwater samples

SAP Worksheet #17—Sampling Design and Rationale (continued)

Matrix	Depths to Sample	Analysis	Method	Number of Samples	Rationale	* Sampling Strategy
Groundwater	Middle of screen	VOCs, explosives, perchlorate, 3,5-dinitroaniline, metals, pesticide/PCBs, pH, TOC, chloride, nitrate, nitrite, sulfate, sulfide, TOC, alkalinity, ferrous iron and methane.	SW-846 8260C SW-846 8330A SW-846 6850 SW-846 6010C SW-846 8081B SW-846 8082A EPA 300.0 SM4500-S2-F SW-846 9060 SM2023B SM3500-Fe-D RSK175 Lloyd Kahn	11 (7 new and 4 existing)	Samples will be collected to determine if contaminants are present in groundwater and if natural attenuation is occurring	An additional round of groundwater samples will be collected from all of the newly installed and existing groundwater monitoring wells, if seeps/pore water samples are determined to be necessary

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference[4]
First Sampling Event					
YS07-SO001 /YS07-SB01-MMYY1 YS07-SO002 /YS07-SB02-MMYY YS07-SO003/YS07-SB03-MMYY YS07-SO003 /YS07-SB03-MMYY-MS YS07-SO003 /YS07-SB03-MMYY-SD YS07-SO004/YS07-SB04-MMYY YS07-SO004/YS07-SB04P-MMYY YS07-SO005 /YS07-SB05-MMYY YS07-SO006 /YS07-SB06-MMYY YS07-SO007/YS07-SB07-MMYY YS07-SO008 /YS07-SB08-MMYY Etc, for a total of 40 locations, including QA/QC at the appropriate frequency	Subsurface Soil*	6 to 24 inches bgs	VOCs, pesticides/PCBs explosives, perchlorate, 3,5-dinitroaniline, metals, cyanide,, TOCand pH	Four Field Samples Field Duplicate – SS04 MS/MSD – SS03	006_SBLog 007_ShallowSo 009_BlankPrep 010_COC 011_Decon 012_DeconRig 015_LogBook
YS07-SO001 /YS07-SS01-MMYY1 YS07-SO002 /YS07-SS02-MMYY YS07-SO003/YS07-SS03-MMYY YS07-SO003 /YS07-SS03-MMYY-MS YS07-SO003 /YS07-SS03-MMYY-SD YS07-SO004/YS07-SS04-MMYY YS07-SO004/YS07-SS04P-MMYY YS07-SO005 /YS07-SS05-MMYY YS07-SO006 /YS07-SS06-MMYY YS07-SO007/YS07-SS07-MMYY YS07-SO008 /YS07-SS08-MMYY Etc, for a maximum total of 40 locations, including QA/QC at the appropriate frequency	Surface Soil*	0 to 6 inches bgs	VOCs, pesticides/PCBs explosives, perchlorate, 3,5-dinitroaniline, metals, cyanide, TOC and pH	Four Field Samples Field Duplicate – SS04 MS/MSD – SS03	006_SBLog 007_ShallowSo 009_BlankPrep 010_COC 011_Decon 012_DeconRig 015_LogBook

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location /ID Number	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference4
YS07-GW001 /YS07-MW01-MMYY1 YS07-GW002 /YS07-MW02-MMYY YS07-GW002/YS07-MW02P-MMYY YS07-GW003/YS07-MW03-MMYY YS07-GW003 /YS07-MW03-MMYY-MS YS07-GW003 /YS07-MW03-MMYY-SD YS07-GW005 /YS07-MW05-MMYY1 YS07-GW006 /YS07-MW06-MMYY YS07-GW007/YS07-MW07-MMYY YS07-GW008 /YS07-MW08-MMYY YS07-GW009 /YS07-MW09-MMYY YS07-GW0010/YS07-MW10-MMYY YS07-GW0011/YS07-MW11-MMYY YS07-GW0011/YS07-MW11P-MMYY YS07-GW0012 /YS07-MW12-MMYY	Groundwater	Middle of screen	VOCs, Pesticides/PCBs explosives, perchlorate, 3,5-dinitroaniline, total and dissolved metals, cyanide chloride, nitrate, nitrite, sulfate, sulfide, TOC, alkalinity, ferrous iron and methane.	10 Field Samples 2 Field Duplicates – MW02 and MW011 MS/MSD – MW03	001_Filter 002_HoribaU22 003_LowFlow 007_Preserve 008_WaterLevels
YS07-SD011/YS07-SD11-MMYY YS07-SD012/YS07-SD12-MMYY YS07-SD012/YS07-SD12-MMYY-MS YS07-SD012/YS07-SD12-MMYY-SD YS07-SD013/YS07-SD13-MMYY YS07-SD014/YS07-SD14-MMYY YS07-SD014/YS07-SD14P-MMYY	Sediment**	0-4 inches	VOCs, pesticides/PCBs, explosives, perchlorate, 3,5-dinitroaniline, metals, cyanide, pH and TOC	4	018_SedSamp

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location /ID Number	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference4
Second Sampling Event					
Same wells and sample nomenclature as for first event, but with correct month and year in the sample ID.	Groundwater	Same as for first event	Same as for first event	Same as for first event	Same as for first event
YS07-SD015/YS07-SD15-MMYY YS07-SD016/YS07-SD16-MMYY YS07-SD016/YS07-SD16-MMYY-MS YS07-SD016/YS07-SD16-MMYY-SD YS07-SD017/YS07-SD17-MMYY YS07-SD018/YS07-SD18-MMYY YS07-SD019/YS07-SD19-MMYY YS07-SD020/YS07-SD20-MMYY YS07-SD021/YS07-SD21-MMYY YS07-SD021/YS07-SD21P-MMYY YS07-SD022/YS07-SD22-MMYY	Sediment**	0-4 inches	TBD based on results of primary conveyor area soil samples	Minimum of 8	018_SedSamp
YS07-SW011/YS07-SW11-MMYY YS07-SW012 / YS07-SW12-MMYY YS07-SW013 / YS07-SW13-MMYY YS07-SW013 / YS07-SW13P-MMYY YS07-SW014 / YS07-SW14-MMYY YS07-SW015 / YS07-SW15-MMYY YS07-SW015 / YS07-SW15-MMYY-MS YS07-SW015 / YS07-SW15-MMYY-SD YS07-SW016 / YS07-SW16-MMYY YS07-SW017 / YS07-SW17-MMYY YS07-SW018 / YS07-SW18-MMYY	Surface Water**	NA	TBD based on primary sample results and team discussion	Minimum of 8	019_SWSamp

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location /ID Number	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference4
YS07-SP001/YS07-SP01-MMYY YS07-SP002/YS07-SP02-MMYY YS07-SP002/YS07-SP02-MMYY-MS YS07-SP002/YS07-SP02-MMYY-SD YS07-SP003/YS07-SP03-MMYY YS07-SP004/YS07-SP04-MMYY YS07-SP004/YS07-SP04P-MMYY YS07-SP005/YS07-SP05-MMYY YS07-SP006/YS07-SP06-MMYY YS07-SP007/YS07-SP07-MMYY YS07-SP008/YS07-SP08-MMYY	Seeps**	NA	TBD based on primary sample results and team discussion	Up to 8	020_Seep
YS07-PW001/YS07-PW01-MMYY YS07-PW001/YS07-PW01P-MMYY YS07-PW002/YS07-PW02-MMYY YS07-PW003/YS07-PW03-MMYY YS07-PW003/YS07-PW03-MMYY-MS YS07-PW003/YS07-PW03-MMYY-SD YS07-PW004/YS07-PW04-MMYY YS07-PW005/YS07-PW05-MMYY YS07-PW006/YS07-PW06-MMYY YS07-PW007/YS07-PW07-MMYY YS07-PW008/YS07-PW08-MMYY	Pore Water**	0-6 inches	TBD based on primary sample results and team discussion	Up to 8	021_PoreWater

*Only primary conveyor belt and Building 504 and 505 samples are listed. Any secondary samples will be numbered sequentially and additional duplicates and MS.MSDs will be collected at a rate of one per ten and one per twenty samples, respectively.

**All SW, SD, pore water and seeps samples are contingency samples to be collected based on the results of soil and groundwater sampling. Only the format for the first sample is listed. Any additional samples will be numbered sequentially and additional duplicates and MS.MSDs will be collected at a rate of one per ten and one per twenty samples, respectively.

SAP Worksheet #19—Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference[1]	Containers (Number, Size, and Type)	Minimum Sample Amount	Preservation Requirements (Chemical, Temperature, Light Protected)	Maximum Holding Time (Preparation/Analysis)[2]
Surface Soil, Subsurface Soil, Sediment	VOA	SW-846 8260C /SOP202/225	Three 40 milliliter (mL) glass VOA vials	5 grams (g)	Two water/freeze within 48 hours; one methanol	48 hours to freeze to <-10°C, 14 days from sampling to analysis
	Pesticides	SW-846 8081B /SOP211	One 4-ounce (oz) glass jar	2 g	Cool to 0°C-6°C	14 days until extraction/40 days to analysis
	PCBs	SW-846 8082A /SOP211				
	Explosives	SW-846 8330A & 6850/SOP327, SOP239	One 4-oz glass jar	2 g	Cool to 0°C-6°C	14 days until extraction/40 days to analysis
	Metals	SW-846 6010C & 7471A / SOP100/104/105	One 4-oz glass jar	One 2 g/0.3 g Mercury		180 days to analysis, 28 days mercury
	Cyanide	SW-846 9012B /SOP175/164		1 g		14 days to analysis
	pH	SW-846 9045D /SOP187		10 g		7 days to analysis
	TOC	Lloyd Kahn /SOP221		250 mg		14 days to analysis
Sediment	AVS/SEM	EPA 821-R-91-100/Method/ 6010C SOP104/7470A SOP105		10 g		Sulfide - 14 days to extraction/analysis; Mercury - 28 days to digestion/analysis; Inductively coupled plasma (ICP) - 180 days to digestion/analysis
	Grain-size	American Society for Testing and Materials (ASTM) D422/ Beaver	(2) 16-oz plastic	1 kilogram minimum	None	NA
Groundwater, Surface Water, Pore Water, Seep	VOA	SW-846 8260C /SOP202	Three 40 mL glass VOA vials	40 mL	Hydrochloric acid (HCL) to a pH <2; Cool to 0°C-6°C; No headspace	14 days to analysis
	Explosives	SW-846 8330A/SOP327	Two 1-liter glass amber bottles	1000 mL	Cool to 0°C-6°C	7 days until extraction/ 40 days to analysis
		SW-846 6850/SOP239	250 mL plastic	Perchlorate 10 mL		28 days to analysis
	Total Metals	SW-846 6010C & 7470A / SOP100/103/105	250 mL plastic	50 mL ICP/30 mL mercury	Nitric acide (HNO_3) to a pH<2; Cool to 0°C-6°C	180 days ICP, 28 days mercury
	Total Cyanide	SW-846 9012B /SOP175/164	250 mL plastic	100 mL	Cool to 0°C-6°C, sodium hydroxide (NaOH) to pH > 12	14 days to analysis
	Dissolved Metals	SW-846 6010C & 7470A / SOP100/103/105	250 mL plastic	50 mL ICP/30 Ml mercury	Field filtered then: HNO_3 to a pH<2; Cool to 0°C-6°C	180 days ICP, 28 days mercury

SAP Worksheet #19—Analytical SOP Requirements Table (continued)

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference[1]	Containers (Number, Size, and Type)	Minimum Sample Amount	Preservation Requirements (Chemical, Temperature, Light Protected)	Maximum Holding Time (Preparation/Analysis)[2]
Groundwater	Pesticides	SW-846 8081B /SOP211	Two 1-liter glass amber bottles	1000 mL	Cool to 0°C-6°C	7 days until extraction/40 days to analysis
	PCBs	SW-846 8082A /SOP211				
	Chloride, Nitrate, Nitrite, Sulfate	EPA 300.0 /SOP145	250 mL plastic	5 mL	Cool to 0°C-6°C	Nitrate/Nitrite 48 hours to analysis; chloride/sulfate 28 days to analysis
	Alkalinity	SM 2320B /SOP154		25 mL		14 days to analysis
	Ferrous Iron	SM3500-Fe D /SOP143		50 mL		Analyze as soon as possible
	Sulfide	SM 4500-S2-F /SOP153	250 mL plastic	250 mL	1 mL 2 N zinc acetate with NaOH to a pH >9; Cool to 0°C-6°C	7 days to analysis
	TOC	SW-846 9060/SOP221	250 mL plastic	5 mL	HCL to a pH <2; Cool to 0°C-6°C	28 days to analysis
	Methane	RSK-175 /SOP236	Two 40 mL glass VOA vials	40 mL	HCL to a pH <2; Cool to 0°C-6°C; No headspace	14 days to analysis

[1] See **Worksheet #23**

[2] Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted (not the validated time of sample receipt [VTSR])

SAP Worksheet #20—Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Sampling Locations[2]	No. of Field Duplicates	No. of Equip. Blanks[3]	No. of Trip Blanks[3]	Total No. of Samples to Lab
First Sampling Event						
Surface Soil	VOA	40	4	5	2	51
	Pesticides	40	4	5	-	49
	PCBs	40	4	5	-	49
	Explosives, plus 3,5-Dinitroaniline	40	4	5	-	49
	Perchlorate	40	4	5	-	49
	Metals /Cyanide	40	4	5	-	49
	Wet Chemistry (TOC and pH)	40	-	-	-	40
Subsurface Soil	VOA	40	4	-	1	45
	Pesticides	40	4	-	-	44
	PCBs	40	4	-	-	44
	Explosives, plus 3,5-Dinitroaniline	40	4	-	-	44
	Perchlorate	40	4	-	-	44
	Metals /Cyanide	40	4	-	-	44
	Wet Chemistry (TOC and pH)	40	-	-	-	40
Groundwater	VOA	11	2	3	3	19
	Pesticides	11	2	3	-	16
	PCBs	11	2	3	-	16
	Explosives, plus 3,5-Dinitroaniline	11	2	3	-	16
	Perchlorate	11	2	3	-	16
	Total Metals /Cyanide	11	2	3	-	16

SAP Worksheet #20—Field Quality Control Sample Summary Table (continued)

Matrix	Analytical Group	No. of Sampling Locations[2]	No. of Field Duplicates	No. of Equip. Blanks[3]	No. of Trip Blanks[3]	Total No. of Samples to Lab
	Dissolved Metals	11	2	3	-	16
	Chloride, Nitrate, Nitrite, Sulfate	11	-	-	-	11
	Sulfide	11	-	-	-	11
	TOC	11	-	-	-	11
	Alkalinity	11	-	-	-	11
	Ferrous Iron	11	-	-	-	11
	Methane	11	-	-	-	11
Sediment	VOA	4	1	1	1	7
	Pesticides	4	1	1	-	6
	PCBs	4	1	1	-	6
	Explosives, plus 3,5-Dinitroaniline	4	1	1	-	6
	Perchlorate	4	1	1	-	6
	Metals /Cyanide	4	1	1	-	6
	Wet Chemistry (TOC and pH)	4	-	-	-	4
Second Sampling Event						
Groundwater	VOA	11	2	3	3	19
	Pesticides	11	2	3	-	16
	PCBs	11	2	3	-	16
	Explosives, plus 3,5-Dinitroaniline	11	2	3	-	16
	Perchlorate	11	2	3	-	16
	Total Metals /Cyanide	11	2	3	-	16
	Dissolved Metals	11	2	3	-	16
	Chloride, Nitrate, Nitrite, Sulfate	11	-	-	-	11
	Sulfide	11	-	-	-	11

SAP Worksheet #20—Field Quality Control Sample Summary Table (continued)

Matrix	Analytical Group	No. of Sampling Locations[2]	No. of Field Duplicates	No. of Equip. Blanks[3]	No. of Trip Blanks[3]	Total No. of Samples to Lab
	TOC	11	-	-	-	11
	Alkalinity	11	-	-	-	11
	Ferrous Iron	11	-	-	-	11
	Methane	11	-	-	-	11
Sediment	VOA	8	1	1	2	13
	Explosives, plus 3,5-Dinitroaniline	8	1	1	-	11
	Perchlorate	8	1	1	-	11
	Metals /Cyanide	8	1	1	-	11
	AVS/SEM	8	-	-	-	8
	TOC	8	-	-	-	8
	pH	8	-	-	-	8
	Grain-size	8	-	-	-	8
Surface Water	VOA	8	1	-	1	10
	Explosives, plus 3,5-Dinitroaniline	8	1	-	-	9
	Perchlorate	8	1	-	-	9
	Total Metals /Cyanide	8	1	-	-	9
	Dissolved Metals	8	1	-	-	9
Pore Water	VOA	8	1	1	2	12
	Explosives, plus 3,5-Dinitroaniline	8	1	1	-	10
	Perchlorate	8	1	1	-	10
	Total Metals /Cyanide	8	1	1	-	10
	Dissolved Metals	8	1	1	-	10
Seep	VOA	8	1	-	2	10

SAP Worksheet #20—Field Quality Control Sample Summary Table (continued)

Matrix	Analytical Group	No. of Sampling Locations[2]	No. of Field Duplicates	No. of Equip. Blanks[3]	No. of Trip Blanks[3]	Total No. of Samples to Lab
	Explosives, plus 3,5-Dinitroaniline	8	1	-	-	9
	Perchlorate	8	1	-	-	9
	Total Metals /Cyanide	8	1	-	-	9
	Dissolved Metals	8	1	-	-	9

[1] Although the MS/MSD is not typically considered a field QC, it is included here because location determination is often established in the field.

[2] If samples will be collected at different depths at the same location, count each discrete sampling depth as a separate sampling location or station.

[3] The number of equipment blanks is based on a fundamental assumption of the number of sampling days each site will require.

[4] Groundwater samples will only be collected for Pesticides and PCBs only if these constituents are detected in the surface soil and subsurface soil samples from the first sampling event. Should groundwater samples be collected, the number of samples will be dependent on the location of any detected soil contamination.

SAP Worksheet #21—Project Sampling SOP References Table

Reference Number	Title, Revision Date and /or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
001_Filter	*Field Filtering, 5/2011*	CH2M HILL	Filter, pump, gloves, bottles, preservatives	N	
002_HoribaU22	*Field Measurement of pH, Specific Conductance, Turbidity, DO, ORP, and Temperature using the Horiba U-22 with Flow-through cell, 5/2011*	CH2M HILL	Horiba U-22 water quality checker with flow-through cell, distilled water, Horiba U-22 auto-calibration standard solution	N	
003_LowFlow	*Low-Flow Groundwater Sampling from Monitoring Wells, 5/2011*	CH2M HILL	Flow through cell, Horiba U-22, water level indicator, filter (if necessary), adjustable rate pump, polyethylene tubing, plastic sheets, well construction info, measuring cup, bucket, sample containers	N	
004_MWInstal	*General Guidance for Monitoring Well Installation, 5/2011*	CH2M HILL	Drill rig with mud rotary or hollow stem auger capability, bentonite, cement-bentonite grout, Schedule 40 PVC, factory slotted well screen, PVC cap, silica sand, well casing (flushmount or stickup), surge block, pump, 55-gallon drum, Horiba U-22, water level	N	
005_MWShall	*Installation of Shallow Monitoring Wells, 5/2011*	CH2M HILL	Drill rig with hollow stem auger capability, bentonite, cement-bentonite grout, Schedule 40 PVC, factory slotted well screen, PVC cap, silica sand, well casing (flushmount or stickup), surge block, pump, 55-gallon drum, Horiba U-22, water level	N	
006_SBLog	*Logging of Soil Borings, 5/2011*	CH2M HILL	Indelible pen, ruler, spatula, rock or soil chart (Munsell), grain size chart, hand lens, squirt bottle, soil chart	N	
007_ShallowSo	*Shallow soil sampling, 5/2011*	CH2M HILL	Sample jars, gloves, trowel	N	
008_WaterLevels	*Water-Level Measurements, 5/2011*	CH2M HILL	Electronic water-level meter with interface probe	N	
009_BlankPrep	*Equipment Blank and Field Blank Preparation, 5/2011*	CH2M HILL	Blank liquid (use ASTM Type II grade water), De-ionized water, sample bottles, gloves, preservatives	N	

SAP Worksheet #21—Project Sampling SOP References Table (continued)

Reference Number	Title, Revision Date and /or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
010_COC	*Chain-of-Custody, 5/2011*	CH2M HILL	Paper chain of custody form (provided by laboratory)	N	
011_Decon	*Decontamination of Personnel and Equipment, 5/2011*	CH2M HILL	De-ionized water, distilled water, potable water, 2.5 percent liquinox and water solution, methanol, plastic pails, 55-gallon drum for waste, gloves, decon pad, steam cleaner	N	
012_DeconRig	*Decontamination of Drilling Rigs and Equipment, 5/2011*	CH2M HILL	Steam cleaner, potable water, liquinox, buckets, brushes, distilled water, methanol, deionized water, aluminum foil	N	
013_Dispose	*Disposal of Waste Fluids and Solids, 5/2011*	CH2M HILL	Fluids-55-gallon drum, tools to secure drum, funnel, labels, marking pen, seals for drum Solids-55-gallon drum, tools to secure drum, plastic sheets, labels, marking pen	N	
014_DrumSample	*Sampling Contents of Tanks and Drums, 5/2011*	CH2M HILL	Drum/tank, sampling instrument, gloves, plastic sheets, labels, monitoring instrument	N	
016_Ship	*Packaging and Shipping Procedures, 5/2011*	CH2M HILL	Coolers, duct tape, ice, strapping tape, packaging material, Ziploc bags, custody seals, chain of custody	N	
017_Utility Location	*Locating and Clearing Underground Utilities, 5/2011*	CH2M HILL	Subsurface locating instruments, spray paint (provided by utility locating contractor), historical documents, facility as built diagrams	N	
018_SedSamp	*Sediment Sampling, 5/2011*	CH2M HILL	Trowel, auger or dredge, bottleware, gloves	N	
019_ SWSamp	*Surface water Sampling, 5/2011*	CH2M HILL	Bottleware, gloves, Horiba U22	N	
020_Seep	*Seep Sampling, 5/2011*	CH2M HILL	Bottleware, gloves	N	
021_Porewater	*Porewater sampling, 5/2011*	USEPA	Passive samplers, gloves, bottleware	N	

SAP Worksheet #22—Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference[1]
Horiba U-22		Check mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check.	Visual inspection		Daily before use, at the end of the day, and when unstable readings occur.	Stable readings after 3 minutes. pH reads 4.0 ±3 percent conductivity reads 4.49 ± 3 percent turbidity reads 0 ± 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	HoribaU22
Groundwater sampling pumps and tubing				Inspect pumps, tubing and air/sample line quick connects	Regularly	Maintained in good working order per manufacturer's recommendations	Replace items		F103, F105, F107, F201

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SAP Worksheet #23—Analytical SOP References Table

Lab SOP Number	Title, Revision Date and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work (Y/N)
QS10	*Laboratory Sample Receiving, Log In and Storage Rev16 20101117*	NA	Login and Storage	NA	Empirical	N
QS14	*Analytical Laboratory Waste Disposal Rev6 20100831*	NA	Waste Disposal	NA	Empirical	N
100	*Metals Digestion/Preparation Methods 3005A/USEPA CLPILM0 4.1 Aqueous, 3010A, 3030C, 3050B USEPA CLPILM0 4.1 (Soil/Sediment), 200.7, Standard Methods 3030C 21st See Addendum for USEPA Contract Laboratory Program (CLP) Inorganic Laboratory Method (ILM) 05.2 (Aqueous & Soil/Sediment) Rev22 20101117*	Definitive	Metals - Digestion Water/Soil	None	Empirical	N
103	*Mercury Analysis in Water by Manual Cold Vapor Technique Methods USEPA SW846 7470A & 245.1 CLP-M 4.1 (NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION [NJDEP] DOES NOT ACCEPT CLPILM 04.1 AFTER JUNE, 2003), ADDENDUM FOR USEPA CLP ILM 05.2 Rev19 20101117*	Definitive	Mercury Water	Cold Vapor Atomic Absorption (CVAA)	Empirical	N
104	*Mercury Analysis in Soil/Sediment by Manual Cold Vapor Technique Methods SW846 7471A, 7471B , EPA 245.5 & CLP ILM 04.1 (NJDEP DOES NOT ACCEPT CLPILM 04.1 AFTER JUNE, 2003), ADDENDUM FOR USEPA CLP ILM 05.2 Rev20 20110516*	Definitive	Mercury Soil	CVAA	Empirical	N
105	*METALS BY ICP-ATOMIC EMISSION SPECTROMETRY (AES) TECHNIQUE References: SW-846, Method 6010B, December 1996; SW-846, Method 6010C, Revision 3 February 2007; USEPA, Method 200.7, June 1991; Standard Methods 19th Edition 2340B; 1995 USEPA CLP, ILM 04.1. See Addendum for USEPA CLPILM 05.2 Rev17 20110516*	Definitive	Metals Water/Soil	ICP- AES	Empirical	N

SAP Worksheet #23—Analytical SOP References Table (continued)

Lab SOP Number	Title, Revision Date and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work (Y/N)
143	*Determination of Ferrous Iron by Standard Methods 3500-Fe B 4c Phenanthroline Method Using HACH AccuVac Ampuls from Method 8146 Rev1 20100907*	Screening	General Chemistry Water	Hach	Empirical	N
145	*Determination of Inorganic Anions in water by Ion Chromatograph (IC) using the Dionex dx-500 IC with Hydroxide Eluent And Dionex AS18 Column, USEPA Method 300.0/SW846 Method 9056 Rev8, 20110516*	Screening	Anions Water	IC	Empirical	N
153	*Sulfide by Method 376.1 and Standard Methods SM4500S F(21st ED, Titrimetric, Iodine) with Sample Pretreatment to Remove Interfering Substances or to Concentrate the Sulfide Rev4 20100907*	Screening	Sulfide Water	Titrimetric	Empirical	N
154	*Total Alkalinity, Carbonate, Bicarbonate by Method USEPA 310.1, SM2320B (20th and 21st Edition) Rev7 20100921*	Screening	Alkalinity Water	Probe	Empirical	N
164	*Distillation of Aqueous/Solid Samples for Cyanide, Total and Amenable; SW846 METHOD 9012A, USEPA Methods 335.1, 335.4, Standard Methods SM 4500-CN C,G, 18th, 19th ED. /CLP ILMO 4.1See Addendum for USEPA CLPILM 05.2 (Aqueous, Soil/Sediment) Rev16 20110516*	Definitive	Cyanide Distillation Water/Soil	NA	Empirical	N
175	*Post-Distillation Analysis for Cyanide Using LACHAT Flow Injection Analyzer Methods 335.4;(SW846) 9012A/B, Standard Methods 21st Edition USEPA-CLP 4.1, (NJDEP does not accept CLPILM 04.1 after June, 2003) Addendum for USEPA CLPILM 05.2 Aqueous & Soil/Sediment Rev11 20100907*	Definitive	Cyanide Water/Soil	Lachat	Empirical	N

SAP Worksheet #23—Analytical SOP References Table (continued)

Lab SOP Number	Title, Revision Date and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work (Y/N)
187	*Electrometric Determination of pH Rev9 20110119*	Screening	pH Water/Soil	Probe	Empirical	N
202	*Gas Chromatography/Mass Spectrometry (GC/MS) Volatiles by USEPA Method 624 & SW846 Method 8260B Including Appendix IX Compounds Rev23 20100909*	Definitive	VOA Water/Soil	Agilent GC/MS	Empirical	N
211	*Gas Chromatography (GC)/Electron Capture Detector (ECD) Organochlorine Pesticides/PCB by USEPA Method 608/6082 or SW-846 Method 8081A/8082 or 8081B/8082A Rev23 20100920*	Definitive	Pest/PCB Water/Soil	Agilent GC/ECD	Empirical	N
343	*BNA & Pesticide/PCBs & Total Petroleum Hydrocarbon (TPH) Non-Aqueous Matrix (Microwave Extraction) Using SW-846 Method 3546 Rev 02 20101117*	Definitive	Pest/PCB Water/Soil	Agilent GC/ECD	Empirical	N
221	*TOC by SM5310C, SW846 Method 9060/9060A and Lloyd Kahn Method "Determination of TOC in Sediment" Rev9 20100712*	Screening	TOC Water/Soil	TOC Analyzer	Empirical	N
225	*GC/MS Volatile Non-Aqueous Matrix Extraction Using SW-846 Method 5035/5035A for 8260B Analysis Rev9 20100907*	Definitive	VOC Soil Preparation	NA	Empirical	N
236	*Methane, Ethane, Ethene in Aqueous Samples by Modified RSK-175 (Automated Headspace) Rev2 20100907*	Screening	Methane, Ethane, Ethene Water	Agilent GC/Flame Ionization Detector (FID)	Empirical	N
239	*Perchlorate in Water, Soil, and Solid Waste Using High Performance Liquid Chromatography (HPLC)/Electrospray Ionization/MS by SW846 Method 6850 Rev6 20101117*	Definitive	Perchlorate Water/Soil	Agilent/Liquid Chromatography (LC)/MS	Empirical	N
302	*Pesticide/PCBs Aqueous Matrix Extraction for USEPA Method 608/608.2 and SW846 Method 8081/8082 Using SW846 Method 3510C, Rev19, 20110112*	Definitive	Pest/PCB Water Prep	Preparation	Empirical	N
343	*BNA & Pesticide/PCBs & TPH Non-Aqueous Matrix (Microwave Extraction) Using SW-846 Method 3546 Rev 02 20101117*	Definitive	Pest/PCB Soil Prep	Preparation	Empirical	N
327	*Nitroaromatics and Nitramines by HPLC Method 8330, 8330A, 8330B and 8332 Rev19 20101005*	Definitive	Explosives Water/Soil	HPLC/Ultra Violet-Visible Spectroscopy (UV-VIS)	Empirical	N
ASTM D422	*Standard Test Method for Particle-Size Analysis of Soils, Designation D 422-63, Reapproved 1990*	Screening	Grain-Size Soil	NA	Beaver Engineering	N

[1] This SOP was undergoing laboratory review at the time of the release of this SAP.

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SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CAs	Person Responsible for CA	SOP Reference
GC/MS (SW-846 8260B)	Tuning	Prior to initial calibration (ICAL) and at the beginning of each 12-hour period.	Refer to method for specific ion criteria.	Retune instrument and verify. Rerun affected samples. Flagging criteria are not appropriate.	Analyst	SOP202
	ICAL - for all analytes a minimum of five points must be used for linear regression, six points for second order regression, or seven for third order regression.	ICAL prior to sample analysis.	1) Average response factor (RF) for system performance check compounds (SPCCs): VOCs ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane; ≥ 0.1 for chloromethane, bromoform and 1,1-dichloroethane. 2) Relative standard deviation (RSD) for RFs for calibration check compounds (CCCs): VOCs ≤ 30 percent and one option below: -Option 1: RSD for each analyte ≤ 15 percent. -Option 2: linear least squares regression correlation coefficient (r) ≥ 0.995. -Option 3: non-linear regression coefficient of determination (COD) r^2 ≥ 0.99.	Correct problem then repeat ICAL. Flagging criteria are not appropriate.		
	Second Source Initial Calibration Verification (ICV)	Once after each ICAL.	All project analytes within ± 20 percent of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL. Flagging criteria are not appropriate.		
GC/MS (SW-846 8260B)	Retention time window position establishment	Once after each ICAL for each analyte and surrogate.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial continuing calibration verification (CCV) is used.	NA	Analyst	
	Evaluation of relative retention times (RRTs)	With each sample.	RRT of each target analyte within ± 0.06 RRT units.	Correct problem, then rerun ICAL. Flagging criteria are not appropriate.		
	CCV	Daily before sample analysis and every 12 hours of analysis time.	1) Average RF for SPCCs: VOCs ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane; ≥ 0.1 for chloromethane, bromoform and 1,1-dichloroethane. 2) Percent Difference/Drift (%D) for all target compounds and surrogates: VOCs ≤ 20 percent D (Note, D = Difference when using RFs, D = Drift when using least squares regression or non-linear calibration.)	DoD project level approval must be obtained for each of the failed analytes or CA must be taken. Correct problem, then rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV. If reanalysis cannot be preformed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since last acceptable CCV.		

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CAs	Person Responsible for CA	SOP Reference
GC/ECD (SW-846 8081B and 8082A)	ICAL	Upon instrument receipt, for major instrument changes, or when CCV does not meet criteria	Pesticides: Minimum 5-point ICAL for all pesticides including toxaphene and technical chlordane (6-point ICAL for non-linear) PCBs: Minimum 5-point ICAL for Aroclor 1016/1260; mid-point Calibration standard for all other Aroclors (Note - quantitation for other Aroclors requires complete Calibration) (6 points for non-linear) GENERAL: %RSD <20 percent; or Linear regression R-Squared >0.990 (R>0.995); or Non-linear regression R-Squared ≥ 0.990 (6 pts for non-linear).	Repeat Calibration if criteria are not met	Analyst	SOP211
	ICV	After ICAL	≤ 20 %D	Correct problem; rerun ICV. If that fails, repeat ICAL.	Analyst	
	Retention time window position establishment	Once after each ICAL for each analyte and surrogate.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	NA		
	CCV	Daily, after every 10 field samples, after each sequence	≤ 20 %D	Correct problem then rerun CCV. If that fails, repeat ICAL and reanalyze all samples since the last successful CCV.		
	Breakdown Check (Pesticides only)	At the beginning of each 12-hour period prior to the analysis of samples.	Degradation < 15 percent for both endrin and DDT.	Correct problem then recheck for both DDT and endrin.		
HPLC/UV-vis (SW-846 8330A)	ICAL - minimum five-points for all analytes	ICAL prior to sample analysis. Once calibration curve or line is generated, the lowest calibration standard must be reanalyzed.	The apparent signal-to-noise ratio at the RL must be at least 5:1. RSD for each analyte ≤ 15 percent or, linear least squares regression r ≥ 0.995 or, non-linear regression COD r2 ≥ 0.99.	Correct problem then repeat ICAL. Flagging criteria are not appropriate.	Analyst	SOP327
	ICV	Immediately following ICAL.	All project analytes and surrogates within ± 20 percent of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL. Flagging criteria are not appropriate.		
	CCV	Prior to sample analysis, after every 10 field samples, and at the end of the analysis sequence.	All target analytes and surrogates within ± 20 percent of the expected value from the ICAL.	Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since last acceptable CCV.		

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CAs	Person Responsible for CA	SOP Reference
HPLC /ESI /MS (SW-846 6850)	ICAL - minimum of five standards	At method set-up and after major maintenance.	r ≥ 0.995 or RSD ≤ 20 percent. The concentration corresponding to the absolute value of the calibration curve's Y-intercept must be ≤ LOD.	Correct problem then repeat ICAL. Flagging criteria are not appropriate.	Analyst	SOP329
	ICV	Once after each ICAL, analysis of a second source standard at the midpoint of the calibration.	Within ±15 percent of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL. Flagging criteria are not appropriate.		
	CCV	Analysis of mid-level standard after every 10 field samples. All samples must be bracketed by the analysis of a standard demonstrating that the system was capable of accurately detecting and quantifying perchlorate.	Within ±15 percent of true value.	Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since last acceptable CCV.		
	Tuning	Prior to ICAL and after any mass calibration or maintenance is performed.	Tuning standards must contain the analytes of interest and meet acceptance criteria outlined in the laboratory SOP.	Retune instrument. If the tuning will not meet acceptance criteria, an instrument mass calibration must be performed and the tuning redone. Flagging criteria are not appropriate.		
	Limit of Detection Verification (LODV) (per batch)	Prior to sample analysis and at the end of the analysis sequence. It can be analyzed after every 10 samples in order to reduce the reanalysis rate.	Within ± 30 percent of true value.	Correct problem and rerun LODV and all samples analyzed since last successful LODV. If a sample with perchlorate concentration at or between the LOD and RL is bracketed by a failing LODV, it must be reanalyzed. A sample with concentration above the RL can be reported. If reanalysis cannot be performed, all samples since the last acceptable LODV must be qualified and explained in the case narrative.		
	Mass Calibration	Instrument must have a valid mass calibration prior to any sample analysis. The mass calibration is updated on an as-needed basis (e.g., QC failures, ion masses show large deviations from known masses, major instrument maintenance is performed, or the instrument is moved).	Mass calibration range must bracket the ion masses of interest without greatly exceeding the range. The most recent mass calibration must be used for an analytical run, and the same mass calibration must be used for all data files in an analytical run. Mass calibration must be verified by acquiring a full scan continuum mass spectrum of a perchlorate stock standard. Perchlorate ions should be within ± 0.3 m/z of mass 99, 101, and 107 or their respective daughter ion masses (83, 85, and 89), depending on which ions are quantitated.	If the mass calibration fails, recalibrate. If it still fails, consult manufacturer instructions on corrective maintenance. Flagging criteria are not appropriate.		

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CAs	Person Responsible for CA	SOP Reference
ICP-AES (SW-846 6010C)	Linear dynamic range or high-level check standard	Every 6 months	Within ±10 percent of true value.	NA		SOP105
	ICAL - minimum one high standard and a calibration blank for all analytes	Daily ICAL prior to sample analysis.	If more than one calibration standard is used, r ≥ 0.995.	Correct problem, then repeat ICAL. Flagging criteria are not appropriate.		
	ICV	Once after each ICAL, prior to beginning a sample run.	Value of second source for all analytes(s) within ±10 percent of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL. Flagging criteria are not appropriate.		
	CCV	After every 10 field samples and at the end of the analysis sequence.	Within ± 10 percent of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.		
	Low-level calibration check standard	Daily, after one-point ICAL.	Within ±20 percent of true value.	Correct problem, then reanalyze. Flagging criteria are not appropriate.		
	Calibration Blank	Before beginning a sample run, after every 10 samples, and at end of the analysis sequence.	No analytes detected > LOD.	Correct problem. Re-prep and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed. Apply B-flag to all results for specific analyte(s) in all samples associated with the blank.		
CVAA (SW-846 7470A/7471B)	ICAL - minimum five standards and a calibration blank	Daily ICAL prior to sample analysis.	r ≥0.995.	Correct problem, then repeat ICAL. Flagging criteria are not appropriate.	Analyst	SOP103/104
	ICV	Once after each ICAL, prior to beginning a sample run.	Value of second source for all analytes(s) within ±10 percent of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL. Flagging criteria are not appropriate.		
	CCV	After every 10 field samples and at the end of the analysis sequence.	Within ± 20 percent of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.		
	Calibration Blank	Before beginning a sample run, after every 10 samples, and at end of the analysis sequence.	No analytes detected > LOD.	Correct problem. Re-prep and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed. Apply B-flag to all results for specific analyte(s) in all samples associated with the blank.		

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CAs	Person Responsible for CA	SOP Reference
Colorimeter (SW-846 9012)	ICAL - six standards and a calibration blank	Daily ICAL prior to sample analysis.	r ≥ 0995.	Correct problem, then repeat ICAL. Flagging criteria are not appropriate.	Analyst	SOP175
	Distilled Standards (one high and one low)	Once per multipoint calibration.	Within ±15 percent of true value.	Correct problem, then repeat distilled standards. Flagging criteria are not appropriate.		
	ICV	Once after each ICAL, prior to beginning a sample run.	Within ±15 percent of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL. Flagging criteria are not appropriate.		
pH Meter (SM2320B and SW-846 9045D)	ICAL - minimum of three buffers	Daily prior to sample analysis.	± 0.05 pH units	Perform maintenance/repair. Use new buffers, recalibrate.	Analyst	SOP187
	Calibration Verification	Immediately following the ICAL and every 3 hours.	± 0.2 pH units	Check calibration standards, recalibrate if necessary. Reanalyze affected data.		
TOC Analyzer (SW-846 9060 and Lloyd Kahn)	ICAL	Prior to sample analysis or instrument undergoes a change.	Linear regression R-Squared ≥0.990 (R≥0.995)	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data.	Analyst/Supervisor	SOP221
	ICV	At the beginning and end of the sequence	Within ± 10 percent of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.		
	CCV	Every 10 field samples or every 5 samples if analyzing in quadruplicate, and at the end of the analysis sequence.	Within ± 15 percent of true value.	Check calibration standards, recalibrate if necessary. Reanalyze affected data.		
IC (EPA 300.0)	ICAL - minimum of three standards and a calibration blank	Daily prior to sample analysis.	Linear regression r^2 ≥0.990 or r ≥0.995	Recalibrate and/or perform instrument maintenance. Recalibrate.	Analyst/Supervisor	SOP145
	ICV	Immediately following the ICAL, or daily, prior to sample analysis, whichever is more frequent.	Within ± 10 percent of true value for all target analytes.	Evaluate, repeat, if still failing, recalibrate.		
	CCV	After every 10 field samples and at the end of the analysis sequence.	Within ± 10 percent of true value for all target analytes.	Check problem, recalibrate and reanalyze all samples since last successful CCV. If %D > 110 percent and sample result is ND, narrate with project approval.		

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CAs	Person Responsible for CA	SOP Reference
Spectrophotometer (SM4500-S2-F)	ICAL	Prior to each batch of samples.	r >/= 0.995	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards	Analyst, Supervisor	SOP153
	Continuing Calibration	After every 10 samples and at the end of the run	80-120 percent of True Value	If the LCS fails high, report samples that are <PQL. Recalibrate and/or reanalyze other samples.		
Ferrous Iron (SM3500-Fe-B)	ICAL	Prior to each batch of samples.	r $\geq$ 0.995	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards	Analyst, Supervisor	SOP143
	Continuing Calibration	After every 10 samples and at the end of the run	Within ± 10 percent of true value.	If the CCV fails high, report samples that are <PQL. Recalibrate and/or reanalyze other samples.		
GC/FID (RSK175)	ICAL - minimum five standards for all analytes	Prior to sample analysis or when major instrument changes have occurred.	One of the following: - %RSD $\leq$20 percent - Linear regression r^2 >0.990 (r>0.995) - Non-linear regression r2 ≥ 0.990 (6 point calibration necessary for non-linear regression)	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards	Analyst/Supervisor	SOP236
	ICV	Immediately following the ICAL, or daily, prior to sample analysis, whichever is more frequent.	Within ± 20 percent of true value for all target analytes.	Recalibrate and/or perform instrument maintenance. Recalibrate.		
	CCV	After every 10 field samples and at the end of the analysis sequence.	Within ± 20 percent of true value for all target analytes.	If %D is high and sample result is ND, qualify/narrate with project approval. If %D is low or project approval not received, reanalyze all samples since last successful CCV.		

SAP Worksheet #25—Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference
GC/MS	Replace/clean ion source; clean injector, replace injector liner, replace/clip capillary column, flush/replace tubing on purge and trap; replace trap	VOCs, SVOCs, LOW PAHs	Ion source, injector liner, column, column flow, purge lines, purge flow, trap	As needed	Refer to **Worksheet #24**	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data	Analyst/Supervisor	Empirical SOP 201,202
GC/ECD	Check pressure and gas supply daily. Bake out column, change septa, liner, seal as needed, cut column as needed.	Pesticides, PCBs	Liner, seal, septum, column	Prior to ICAL or as necessary		If %D is high and sample result is ND, qualify/narrate with project approval. If %D is low or project approval not received, reanalyze all samples since last successful CCV.		Empirical SOP 211
Lachat	Flush/replace tubing	Alkalinity	Tubing	As needed		Repeat maintenance activity of remove from service		Empirical SOP 175
ICP-AES	Clean plasma torch; clean filters; clean spray and nebulizer chambers; replace pump tubing	Metals	Torch, filters, nebulizer chamber, pump, pump tubing	Maintenance is performed prior to ICAL or as necessary.		Repeat maintenance activity or remove from service.		Empirical SOP 105
CVAA	Change the tubing, filter, clean windows, and check gas flow. Check the reagents and standards.	Mercury	Inspect the tubing, filter, and the optical cell	Maintenance is performed prior to ICAL or as necessary.		Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data		Empirical SOP 103/104
Liquid Chromatography/Mass Spectrometry (LC/MS)	Change analytical column as needed, change mobile phase when insufficient for run or contamination, change inlet filters as needed for contamination	Perchlorate	Check pump pressure, check for leaks, check for adequate mobile phase	Instrument receipt, instrument change (new column, etc.), when CCV does not meet criteria		Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data		Empirical SOP 239
HPLC/UV-VIS	Change analytical column as needed, change mobile phase when insufficient for run or contamination, change inlet filters as needed for contamination	Explosives	Check pump pressure, check for leaks, check for adequate mobile phase	Prior to ICAL or as necessary		Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data.		Empirical SOP 327
TOC analyzer (TOC)	Replace sample tubing, clean sample boat, replace syringe	TOC	Tubing, sample boat, syringe	As needed		Repeat maintenance activity or remove from service.		Empirical SOP 221
pH Meter (Alkalinity)	Change buffer solutions or pH probe	Alkalinity	Change buffer solutions or pH probe	Before analysis begins, check every 3 hours		Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data		Empirical SOP 154
IC (Nitrate, Nitrite, Sulfate)	Replace column	Anions	Check gas supply, check for leaks, check pistons	Daily or as needed		Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.		Empirical SOP 145
Spectrophotometer (Sulfide)	Clean reagent tubes. Change lamp.	Sulfide	Check wavelength	At the beginning of every run.				Empirical SOP 153
GC/FID(Methane, Ethane, Ethene)	Check pressure and gas supply daily. Bake out column, change septa, liner, seal as needed, cut column as needed.	Methane, Ethane, Ethene	Liner, seal, septum, column	Prior to ICAL or as necessary				Empirical SOP 236

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SAP Worksheet #26—Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Field Team Members/CH2M HILL
Sample Packaging (Personnel/Organization): Field Team Members/CH2M HILL
Coordination of Shipment (Personnel/Organization): FTL/CH2M HILL
Type of Shipment/Carrier: FedEx Overnight
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Receiving/Empirical Laboratories, LLC, Beaver Engineering
Sample Custody and Storage (Personnel/Organization): Sample Receiving/Empirical Laboratories, LLC, Beaver Engineering
Sample Preparation (Personnel/Organization): Extraction, Metals Prep, Wet Chem. /Empirical Laboratories, LLC, Beaver Engineering
Sample Determinative Analysis (Personnel/Organization): VOA, Explosives, Metals, Wet Chem. /Empirical Laboratories, LLC and Grain-size / Beaver Engineering
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 90 days from receipt
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 30 days
Biological Sample Storage (No. of days from sample collection): NA
SAMPLE DISPOSAL
Personnel/Organization: Sample Disposal /Empirical Laboratories, LLC , Beaver Engineering
Number of Days from Analysis: 60 days

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SAP Worksheet #27—Sample Custody Requirements Table

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):
Samples will be collected by field team members under the supervision of the FTL. As samples are collected, they will be placed into containers and labeled. Labels will be taped to the jar to ensure they do not separate. Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples less than six degrees °C (without freezing the sample) until they are received by the laboratory. The chain of custody will be placed into the cooler in a resealable plastic bag. Coolers will be taped up and shipped to the laboratories via FedEx overnight, with the air bill number indicated on the chain-of-custody (to relinquish custody). Upon delivery, the laboratory will log in each cooler and report the status of the samples to CH2M HILL. See **Worksheet #21** for SOPs containing sample custody guidance. The CH2M HILL field team will ship all environmental samples to Empirical Laboratories, LLC. Empirical will ship grain size samples to Beaver Engineering.
Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):
Laboratory custody procedures can be found in the following SOP, which is referenced in **Worksheet #23** and can be found in **Appendix B** of this SAP: SOP-QS10
Sample ID Procedures:
Sample labels will include, at a minimum, client name, site, sample ID, date/time collected, analysis group or method, preservation, and sampler's initials. The field logbook will identify the sample ID with the location and time collected and the parameters requested. The laboratory will assign each field sample a laboratory sample ID based on information in the chain of custody. The laboratory will send sample log-in forms to the PDM to check that sample IDs and parameters are correct.
Chain-of-custody Procedures:
Chain of custodies will include, at minimum, laboratory contact information, client contact information, sample information, and relinquished by/received by information. Sample information will include sample ID. Date/time collected, number and type of containers, preservative information, analysis method, and comments. The chain of custody will link location of the sample from the field logbook to the laboratory receipt of the sample. The laboratory will use the sample information to populate the Laboratory Information Management Systems (LIMS) database for each sample.

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SAP Worksheet #28-1—Laboratory Quality Control Samples Table

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: VOA

Analytical Method /SOP Reference: SW-846 8260C /SOP202/225

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per prep batch.	No target analytes detected > ½ LOQ, > 1/10 the concentration found in the sample, or > 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.	Correct problem, then see criteria in Box D-1 of DoD QSM v4.1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst, Supervisor, QA Manager	Accuracy/Bias, Contamination	Same as QC acceptance limits.
LCS	One per prep batch. LCS must contain all analytes to be reported, including surrogates.	QC acceptance criteria specified by DoD, if available. Otherwise, use in-house control limits. Refer to **Worksheet #15-1**.	Correct the problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as QC acceptance limits.
MS	One per prep batch of 20 or fewer samples of similar matrix.	Same as LCS, refer to **Worksheet #15-1**.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as QC acceptance limits.
MSD	One per prep batch of 20 or fewer samples of similar matrix.	Same as MS, refer to **Worksheet #15-1**; RPD ≤ 30 percent.	Same as MS.	Analyst, Supervisor, QA Manager	Accuracy/Bias, Precision	Same as QC acceptance limits.
Internal Standards (ISs) Verification	Every field, QC, and standard, and QC sample.	Retention time ±0.5 minutes compared to RT of the midpoint standard in the ICAL. Extracted Ion Current Profile (EICP) area within -50 percent to +100 percent of ICAL midpoint standard.	Inspect mass spectrometer and gas chromatograph for malfunctions. Reanalysis of samples analyzed while system was malfunctioning is mandatory. If CA fails in field samples, apply Q-flag to analytes associated with the non-compliant IS. Flagging criteria are not applicable for failed standards.	Analyst	Accuracy	Same as QC acceptance limits.
Surrogates	All field and QC samples.	QC acceptance criteria specified by DoD if available. Otherwise, use in-house control limits.DoD criteria:4-Bromofluorobenzene: 85-120 percent Toluene-d8: 85-115 percent	For QC and field samples, correct the problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as QC acceptance limits.

[1]DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-2—Laboratory QC Samples Table

Matrix: Surface Soil and Subsurface Soil

Analytical Group: Pesticides

Analytical Method /SOP Reference: SW-846 8081B

QC Sample[1]	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per prep batch of 20 or fewer samples of similar matrix; or one per day, whichever comes first	No analytes detected > ½ LOQ or > 1/10 sample concentration or >1/10 regulatory limit.	Investigate source of contamination. Rerun method blank prior to analysis of samples if possible. Evaluate the samples and associated QC: if blank results are above LOQ, report sample results which are < LOQ or > 10X the blank concentration.	Analyst/Supervisor	Bias/Contamination	Same as QC Acceptance Limits
LCS	One per prep batch of 20 or fewer samples of similar matrix	QC acceptance criteria specified by DoD, if available. Otherwise, use in-house control limits. Refer to **Worksheet #15-2**	Re-prepare and reanalyze if possible, if not possible, qualify the data and narrate the nature of the exceedance of acceptance limits.	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits
MS/MSD	One per prep batch of 20 or fewer samples of similar matrix (spike same as LCS)	Same as LCS, refer to **Worksheet #15-2**; RPD ≤ 30 percent.	CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met unless RPDs indicate obvious extraction/analysis difficulties, then reprep MS/MSD. Indicate obvious extraction/analysis issues.	Analyst/ Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
Surrogates	Each field and QC sample	TCMX 70-125 percent, DCB 55-130 percent	No CA if only one surrogate is out. If both surrogates are high and sample is < LOQ, no CA is taken. If surrogates are low and sample volume available, re-extract/re-analyze affected samples	Analyst/ Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
Confirmation column	All positive results must be confirmed.	Calibration and QC criteria same as for initial or primary column analysis. Results between primary and second column RPD< 40 percent.	NA	Analyst/Supervisor	Accuracy	Apply qualifier if RPD>40 percent.

[1]DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-3—Laboratory QC Samples Table

Matrix: Surface Soil and Subsurface Soil

Analytical Group: PCBs

Analytical Method /SOP Reference: SW-846 8082A

QC Sample[1]	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per prep batch of twenty or fewer samples of similar matrix; or one per day, whichever comes first	No analytes detected > ½ LOQ or > 1/10 sample concentration or >1/10 regulatory limit.	Investigate source of contamination. Rerun method blank prior to analysis of samples if possible. Evaluate the samples and associated QC: if blank results are above LOQ, report sample results which are < LOQ or > 10X the blank concentration.	Analyst/Supervisor	Bias/Contamination	Same as QC Acceptance Limits
LCS	One per prep batch of twenty or fewer samples of similar matrix	QC acceptance criteria specified by DoD, if available. Otherwise, use in-house control limits. Refer to **Worksheet #15-3**	Re-prepare and reanalyze if possible, if not possible, qualify the data and narrate the nature of the exceedance of acceptance limits.	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits
MS/MSD	One per prep batch of twenty or fewer samples of similar matrix (spike same as LCS)	Same as LCS, refer to **Worksheet #15-3**; RPD ≤ 30 percent.	CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met unless RPDs indicate obvious extraction/analysis difficulties, then reprep MS/MSD. Indicate obvious extraction/analysis issues.	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits
Surrogates	Each field and QC sample	DCB 60-125 percent	No CA if only one surrogate is out. If both surrogates are high and sample is < LOQ, no CA is taken. If surrogates are low and sample volume available, re-extract/re-analyze affected samples	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits
Confirmation column	All positive results must be confirmed.	Calibration and QC criteria same as for initial or primary column analysis. Results between primary and second column RPD< 40 percent.	NA	Analyst/Supervisor	Accuracy	Apply qualifier if RPD>40 percent.

[1]DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-4A—Laboratory QC Samples Table

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: Explosives

Analytical Method /SOP Reference: SW-846 8330A SOP327

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch.	No analytes detected > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/Bias, Contamination	Same as QC Acceptance Limits.
LCS	One per preparatory batch. Must contain all analytes to be reported, including surrogates.	QC acceptance criteria specified by DoD if available. Otherwise, use in-house control limits. In-house control limits may not be greater than ± 3times the standard deviation of the mean LCS recovery. Refer to **Worksheet #15-4**.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MS	One per prep batch of 20 or fewer samples of similar matrix.	Same as LCS.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MSD	One per prep batch of twenty or fewer samples of similar matrix.	Same as MS, refer to **Worksheet #15-4**; RPD ≤ 30 percent.	Same as MS.	Analyst	Accuracy/Bias, Precision	Same as QC Acceptance Limits.
Surrogate Spike	All field and QC samples.	QC acceptance criteria specified by DoD if available. Otherwise, use in-house control limits. In-house: 1-chloro-3-NB 55 percent -140 percent	For QC and field samples, correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated prep batch, if sufficient sample is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	Analyst	Accuracy /Precision	Same as QC Acceptance Limits.
Confirmation of positive results (second column or second detector)	All positive results must be confirmed.	Calibration and QC criteria same as for initial or primary column analysis. Results between primary and second column RPD ≤ 40 percent	Report from both columns. If there is a > 40 percent RPD between the two column results, data must be J-flagged accordingly.	Analyst	Accuracy /Precision	Same as QC Acceptance Limits.

[1]DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-4B—Laboratory QC Samples Table

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: Perchlorate

Analytical Method /SOP Reference: SW-846 6850 /SOP239

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch.	No perchlorate detected > ½ LOQ and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1. If required, reprep and reanalyze method blank and all samples processed with method blank. If reanalysis cannot be preformed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/ Bias, Contamination	Same as QC Acceptance Limits.
LCS	One per preparatory batch. LCS must be spiked at the LOQ.	Recovery within method requirements, laboratory-generated limits, or 80-120 percent (whichever is more stringent) to verify calibration and to check method performance. Refer to **Worksheet #15-4**.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MS	One per preparatory batch per matrix. The MS must be spiked at the LOQ.	Recovery within 80-120 percent or within laboratory generated limits, whichever is more stringent. Refer to **Worksheet #15-4**.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MSD	One per preparatory batch per matrix. The MSD must be spiked at the LOQ.	Same as MS and refer to **Worksheet #15-4**.	Same as MS.	Analyst	Accuracy/ Bias, Precision	Same as QC Acceptance Limits.
Laboratory Reagent Blank	Prior to calibration, after samples with overrange concentration of perchlorate and at the end of the analytical sequence.	No perchlorate detected > 1/2 the LOQ.	Reanalyze reagent blank (until no carryover is observed) and all samples processed since the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Representativeness /Accuracy /Bias	Same as QC Acceptance Limits.
Interference Check Sample (ICS)	Once ICS is prepared with every batch of 20 samples and must undergo the same preparation and pretreatment steps as the samples in the batch. It verifies the method performance at the matrix conductivity threshold (MCT). At least one ICS must be analyzed daily.	Within ±30 percent of true value.	Correct problem and then reanalyze all samples in that batch. If poor recovery from the cleanup filters is suspected, a different lot of filters must be used to reextract all samples in the batch. If column degradation is suspected, a new column must be calibrated before the samples can be reanalyzed. Flagging criteria are not appropriate.	Analyst	Accuracy	Same as QC Acceptance Limits.

SAP Worksheet #28-4B—Laboratory QC Samples Table (continued)

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Isotope ratio 35Cl/37Cl	Every sample, batch QC sample, and standard.	Monitor for either the parent ion at masses 99/101 or the daughter ion at masses 83/85 depending on which ions are quantitated. Theoretical ratio ~3.06. Must fall within 2.3 to 3.8.	If criteria are not met, the sample must be rerun. If the sample was not pretreated, the sample should be reextracted using cleanup procedures. If, after cleanup, the ratio still fails, use alternative techniques to confirm presence of perchlorate (i.e., a post spike sample, dilution to reduce any interference). Apply J-flag if acceptance criteria are not met. Decision to report data failing ratio check should be thoroughly documented in case narrative.	Analyst	Accuracy	Same as QC Acceptance Limits.
IS	Addition of 18O-labeled perchlorate to every sample, batch QC sample, standard, instrument blank, and method blank.	Measured 18O IS area within ±50 percent of the value from the average of the IS area counts of the ICAL. RRT of the perchlorate ion must be 1.0 ± 2 percent (0.98-1.02).	Rerun the sample at increasing dilutions until the ±50 percent acceptance criteria are met. If criteria cannot be met with dilution, the interference are suspected and the sample must be reprepped using additional pretreatment steps. Apply Q-flag and discuss in the case narrative. If peak is not within retention time window, presence is not confirmed. Use for quantitation and to ensure identification. Failing IS should be thoroughly documented in the case narrative.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.

[1]DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-5A—Laboratory QC Samples Table

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: Metals (not including mercury)

Analytical Method /SOP Reference: SW-846 Method 6010C /SOP100/105

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch.	No analytes detected > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/Bias, Contamination	Same as QC Acceptance Limits.
ICS	At the beginning of an analytical run.	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spike analytes); ICS-AB: Within ±20 percent of true value.	Terminate analysis; locate and correct problem; reanalyze ICS; reanalyze all samples. If CA fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the ICS.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
LCS - containing all target analytes	One per preparatory batch.	QC acceptance criteria specified by DoD, if available. Refer to **Worksheet #15-5**.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MS	One per preparatory batch per matrix.	Same as LCS.	Examine the project-specific DQOs. If the MS falls outside of DoD criteria, additional DQ tests are required to evaluate matrix effects. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MSD	One per preparatory batch per matrix.	Same as MS and refer to **Worksheet #15-5**.	Same as MS.	Analyst	Accuracy/Bias, Precision	Same as QC Acceptance Limits.
Dilution Test	One per preparatory batch.	Five-fold dilution must agree within ±10 percent of the original measurement. Only applicable for samples with concentrations > 50X LOQ.	Perform post-digestion spike (PDS) addition.	Analyst	Accuracy	Same as QC Acceptance Limits.
PDS	When dilution test fails or analyte concentration in all samples < 50X LOD.	Recovery within 75-125 percent (refer to Table B-1 of DoD QSM v. 4.1).	Run all associated samples in the preparatory batch by method of standard additions (MSA) or, for the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy	Same as QC Acceptance Limits.

[1]DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-5B—Laboratory QC Samples Table

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: Mercury

Analytical Method /SOP Reference: SW-846 Methods 7470A/7471B /SOP103/104

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch.	No analytes detected > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/ Bias, Contamination	Same as QC Acceptance Limits.
LCS	One per preparatory batch.	QC acceptance criteria specified by DoD, if available. Refer to **Worksheet #15-5**.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MS	One per preparatory batch per matrix.	Same as LCS.	Examine the project-specific DQOs. If the MS falls outside of DoD criteria, additional QC tests are required to evaluate matrix effects. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MSD	One per preparatory batch per matrix.	Same as MS and refer to **Worksheet #15-5**.	Same as MS.	Analyst	Accuracy/Bias, Precision	Same as QC Acceptance Limits.

[1]DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-5C—Laboratory QC Samples Table

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: Cyanide

Analytical Method /SOP Reference: SW-846 Method 9012B /SOP164/175

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch.	No analytes detected > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/ Bias, Contamination	Same as QC Acceptance Limits.
LCS	One per preparatory batch.	QC acceptance criteria specified by DoD, if available. Refer to **Worksheet #15-5**.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MS	One per preparatory batch per matrix.	Same as LCS.	Examine the project-specific DQOs. If the MS falls outside of DoD criteria, the MSA shall be used for the analysis. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MSD	One per preparatory batch per matrix.	Same as MS and refer to **Worksheet #15-5**.	Same as MS.	Analyst	Accuracy/Bias, Precision	Same as QC Acceptance Limits.

[1]DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-6—Laboratory QC Samples Table

Matrix: Surface Soil, Subsurface Soil and/or Sediment

Analytical Group: Wet Chemistry

Analytical Method /SOP Reference: SW-846 9045D, Lloyd Kahn, 821_R-91-100 /SOP187, SOP221, SOP104/SOP105

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
pH (SW-846 9045C)						
LCS	One per batch.	± 0.1 pH units	All samples associated with a failed LCS must be reanalyzed.	Analyst, Laboratory Supervisor	Accuracy, Bias	± 0.1 pH units
Laboratory Replicate	One per batch.	difference of ≤ 0.5 pH units	Advisory. Reanalysis may be done unless obvious matrix issues.	Analyst, Laboratory Supervisor	Accuracy, Bias	difference of ≤ 0.5 pH units
TOC (Lloyd Kahn)						
Method Blank	One per batch.	No analyte detected < 1/2 the reporting limit and 1/10 the amount measured in any sample.	Investigate source of contamination. Rerun method blank.	Analyst, Laboratory Supervisor	Bias/Contamination	No analyte detected < 1/2 the reporting limit and 1/10 the amount measured in any sample.
LCS	One per batch of 20 or fewer samples.	80-120 percent	Reanalyze. Investigate standards and recalibrate if necessary.	Analyst, Laboratory Supervisor	Accuracy, Precision	Refer to **Worksheet #15-4.**
Laboratory Control Sample Duplicate (LCSD)	If no MSD in batch.	Same as LCS; RPD ≤ 20 percent	Same as LCS.	Analyst, Laboratory Supervisor	Accuracy, Precision	Same as LCS, and refer to **Worksheet #15-4**.
Laboratory Quadruplicate	One per batch.	%RSD ≤20 percent	Advisory. Reanalysis may be done unless obvious matrix issues.	Analyst, Laboratory Supervisor	Accuracy, Bias	%RSD ≤20 percent
AVS/SEM (821_R-91-100)						
Method Blank	One per prep batch.	No analyte > PQL	Reprep and reanalyze samples.	Analyst, Supervisor, QA Manager	Accuracy/Bias, Contamination	No analyte > PQL
LCS	One per prep batch.	80-120 percent	Reprep and reanalyze samples.	Analyst, Supervisor, QA Manager	Accuracy/Bias	80-120 percent
Sample Duplicate	One per prep batch.	RSD ≤ 20 percent for results > 3x PQL	Narrate QC failures.	Analyst, Supervisor, QA Manager	Precision	RSD ≤ 20 percent for results > 3x PQL
MS	One per prep batch.	75-125 %R if sample < 4 x spike	Narrate QC failures.	Analyst, Supervisor, QA Manager	Accuracy/Bias	75-125 %R if sample < 4 x spike
MSD[1]	One per prep batch.	Same as MS; RPD ≤ 20 percent	Same as MS.	Analyst, Supervisor, QA Manager	Accuracy/Bias, Precision	Same as MS; RPD ≤ 20 percent

[1]Laboratory SOPs and internal criteria are the basis for specifications on this table.

SAP Worksheet #28-7—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Pore Water, Seep

Analytical Group: VOA

Analytical Method /SOP Reference: SW-846 8260C /SOP202

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per prep batch.	No target analytes detected > ½ LOQ, > 1/10 the concentration found in the sample, or > 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.	Correct problem, then see criteria in Box D-1 of DoD QSM v4.1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst, Supervisor, QA Manager	Accuracy/ Bias, Contamination	Same as QC acceptance limits.
LCS	One per prep batch. LCS must contain all analytes to be reported, including surrogates.	QC acceptance criteria specified by DoD, if available. Otherwise, use in-house control limits. Refer to **Worksheet #15-7**.	Correct the problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as QC acceptance limits.
MS	One per prep batch of twenty or fewer samples of similar matrix.	Same as LCS, refer to **Worksheet 15-7**.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as QC acceptance limits.
MSD	One per prep batch of twenty or fewer samples of similar matrix.	Same as MS, refer to **Worksheet #15-7**; RPD ≤ 30 percent.	Same as MS.	Analyst, Supervisor, QA Manager	Accuracy/Bias, Precision	Same as QC acceptance limits.
ISs Verification	Every field, QC, and standard, and QC sample.	Retention time ±0.5 minutes compared to RT of the midpoint standard in the ICAL. EICP area within -50 percent to +100 percent of ICAL midpoint standard.	Inspect mass spectrometer and gas chromatograph for malfunctions. Reanalysis of samples analyzed while system was malfunctioning is mandatory. If CA fails in field samples, apply Q-flag to analytes associated with the non-compliant IS. Flagging criteria are not applicable for failed standards.	Analyst	Accuracy	Same as QC acceptance limits.
Surrogates	All field and QC samples.	QC acceptance criteria specified by DoD if available. Otherwise, use in-house control limits. DoD criteria: Dibromofluoromethane 85-115 percent; 1,2-dichloroethane-d4 70-120 percent; Toluene-d8 85-120 percent; 4-Bromofluorobenzene 75-120 percent	For QC and field samples, correct the problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as QC acceptance limits.

[1]DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-8—Laboratory QC Samples Table

Matrix: Groundwater

Analytical Group: Pesticides

Analytical Method /SOP Reference: SW-846 8081B /SOP211

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per prep batch of twenty or fewer samples of similar matrix; or one per day, whichever comes first	No analytes detected > ½ LOQ or > 1/10 sample concentration or >1/10 regulatory limit.	Investigate source of contamination. Rerun method blank prior to analysis of samples if possible. Evaluate the samples and associated QC: if blank results are above LOQ, report sample results which are < LOQ or > 10X the blank concentration.	Analyst/Supervisor	Bias/Contamination	Same as QC Acceptance Limits
LCS	One per prep batch of twenty or fewer samples of similar matrix	QC acceptance criteria specified by DoD, if available. Otherwise, use in-house control limits. Refer to **Worksheet #15-8**	Evaluate and reanalyze if possible. If an MS/MSD was extracted in the same extraction batch and acceptable narrate. If the LCS recoveries are high but the sample results are <LOQ narrate. Otherwise reprep and reanalyze	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits
MS/MSD	One per prep batch of twenty or fewer samples of similar matrix (spike same as LCS)	Same as LCS, refer to **Worksheet#15-8**; RPD ≤ 30 percent.	CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met unless RPDs indicate obvious extraction/analysis difficulties, then reprep MS/MSD. Indicate obvious extraction/analysis issues.	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits
Surrogates	Each field and QC sample	TCMX 25-140 percent, DCB 30-135 percent	No CA if only one surrogate is out. If both surrogates are high and sample is < LOQ, no CA is taken. If surrogates are low and sample volume available, re-extract/re-analyze affected samples	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits
Confirmation column	All positive results must be confirmed.	Calibration and QC criteria same as for initial or primary column analysis. Results between primary and second column RPD< 40 percent.	NA	Analyst/Supervisor	Accuracy	Apply qualifier if RPD>40 percent.

[1]DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-9—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Pore Water, Seep

Analytical Group: PCBs

Analytical Method /SOP Reference: SW-846 8082A /SOP211

QC Sample[1]	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per prep batch of twenty or fewer samples of similar matrix; or one per day, whichever comes first	No analytes detected > ½ LOQ or > 1/10 sample concentration or >1/10 regulatory limit.	Investigate source of contamination. Rerun method blank prior to analysis of samples if possible. Evaluate the samples and associated QC: if blank results are above LOQ, report sample results which are < LOQ or > 10X the blank concentration.	Analyst/Supervisor	Bias/Contamination	Same as QC Acceptance Limits
LCS	One per prep batch of twenty or fewer samples of similar matrix	QC acceptance criteria specified by DoD, if available. Otherwise, use in-house control limits. Refer to **Worksheet #15-9**	Evaluate and reanalyze if possible. If an MS/MSD was extracted in the same extraction batch and acceptable narrate. If the LCS recoveries are high but the sample results are <LOQ narrate. Otherwise reprep and reanalyze	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits
MS/MSD	One per prep batch of twenty or fewer samples of similar matrix (spike same as LCS)	Same as LCS, refer to **Worksheet #15-9**; RPD ≤ 30 percent.	CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met unless RPDs indicate obvious extraction/analysis difficulties, then reprep MS/MSD. Indicate obvious extraction/analysis issues.	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits
Surrogates	Each field and QC sample	DCB 40-135 percent	No CA if only one surrogate is out. If both surrogates are high and sample is < LOQ, no CA is taken. If surrogates are low and sample volume available, re-extract/re-analyze affected samples	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits
Confirmation column	All positive results must be confirmed.	Calibration and QC criteria same as for initial or primary column analysis. Results between primary and second column RPD< 40 percent.	NA	Analyst/Supervisor	Accuracy	Apply qualifier if RPD>40 percent.

[1]DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-10A—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Pore Water, Seep

Analytical Group: Explosives

Analytical Method /SOP Reference: SW-846 8330A /SOP327

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch.	No analytes detected > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/Bias, Contamination	Same as QC Acceptance Limits.
LCS	One per preparatory batch. Must contain all analytes to be reported, including surrogates.	QC acceptance criteria specified by DoD if available. Otherwise, use in-house control limits. In-house control limits may not be greater than ± 3times the standard deviation of the mean LCS recovery. Refer to **Worksheet #15-10**.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MS	One per prep batch of twenty or fewer samples of similar matrix.	Same as LCS.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MSD	One per prep batch of twenty or fewer samples of similar matrix.	Same as MS, refer to **Worksheet #15-10**; RPD ≤ 30 percent.	Same as MS.	Analyst	Accuracy/Bias, Precision	Same as QC Acceptance Limits.
Surrogate Spike	All field and QC samples.	QC acceptance criteria specified by DoD if available. Otherwise, use in-house control limits. In-house: 1-chloro-3-NB 40 percent-145 percent	For QC and field samples, correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated prep batch, if sufficient sample is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	Analyst	Accuracy /Precision	Same as QC Acceptance Limits.
Confirmation of positive results (second column or second detector)	All positive results must be confirmed.	Calibration and QC criteria same as for initial or primary column analysis. Results between primary and second column RPD ≤ 40 percent	Report from both columns. If there is a > 40 percent RPD between the two column results, data must be J-flagged accordingly.	Analyst	Accuracy /Precision	Same as QC Acceptance Limits.

[1]DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-10B—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Pore Water, Seep

Analytical Group: Perchlorate

Analytical Method /SOP Reference: SW-846 6850 /SOP329

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch.	No perchlorate detected > ½ LOQ and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1. If required, reprep and reanalyze method blank and all samples processed with method blank. If reanalysis cannot be preformed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/ Bias, Contamination	Same as QC Acceptance Limits.
LCS	One per preparatory batch. LCS must be spiked at the LOQ.	Recovery within method requirements, laboratory-generated limits, or 80-120 percent (whichever is more stringent) to verify calibration and to check method performance. Refer to **Worksheet #15-10**.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MS	One per preparatory batch per matrix. The MS must be spiked at the LOQ.	Recovery within 80-120 percent or within laboratory generated limits, whichever is more stringent. Refer to **Worksheet #15-10**.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MSD	One per preparatory batch per matrix. The MSD must be spiked at the LOQ.	Same as MS and refer to **Worksheet #15-10**.	Same as MS.	Analyst	Accuracy/Bias, Precision	Same as QC Acceptance Limits.
Laboratory Reagent Blank	Prior to calibration, after samples with overrange concentration of perchlorate and at the end of the analytical sequence.	No perchlorate detected > 1/2 the LOQ.	Reanalyze reagent blank (until no carryover is observed) and all samples processed since the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Representativeness/ Accuracy/Bias	Same as QC Acceptance Limits.
ICS	Once ICS is prepared with every batch of 20 samples and must undergo the samepreparation and pretreatment steps as the samples in thebatch. It verifies the method performance at the MCT. At least one ICS must be analyzed daily.	Within ±30 percent of truevalue.	Correct problem and then reanalyze all samples in that batch. If poor recovery from the cleanup filters is suspected, a different lot of filters must be used to reextract all samples in the batch. If column degradation is suspected, a new column must be calibrated before the samples can be reanalyzed. Flagging criteria are not appropriate.	Analyst	Accuracy	Same as QC Acceptance Limits.
Isotope ratio 35Cl/37Cl	Every sample, batch QC sample, and standard.	Monitor for either the parent ion at masses 99/101 or the daughter ion at masses 83/85 depending on which ions are quantitated. Theoretical ratio ~3.06. Must fall within 2.3 to 3.8.	If criteria are not met, the sample must be rerun. If the sample was not pretreated, the sample should be reextracted using cleanup procedures. If, after cleanup, the ratio still fails, use alternative techniques to confirm presence of perchlorate (i.e., a post spike sample, dilution to reduce any interference, etc.). Apply J-flag if acceptance criteria are not met. Decision to report data failing ratio check should be thoroughly documented in case narrative.	Analyst	Accuracy	Same as QC Acceptance Limits.
IS	Addition of 18O-labeled perchlorate to every sample, batch QC sample, standard, instrument blank, and method blank.	Measured 18O IS area within ±50 percent of the value from the average of the IS area counts of the ICAL. RRT of the perchlorate ion must be 1.0 ± 2 percent (0.98-1.02).	Rerun the sample at increasing dilutions until the ±50 percent acceptance criteria are met. If criteria cannot be met with dilution, the interference are suspected and the sample must be reprepped using additional pretreatment steps. Apply Q-flag and discuss in the case narrative. If peak is not within retention time window, presence is not confirmed. Use for quantitation and to ensure identification. Failing IS should be thoroughly documented in the case narrative.	Analyst	Accuracy/ Bias	Same as QC Acceptance Limits.

[1]DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-11A—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Pore Water, Seep

Analytical Group: Total Metals and Dissolved Metals (not including mercury)

Analytical Method /SOP Reference: SW-846 Method 6010C /SOP100/105

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch.	No analytes detected > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/Bias, Contamination	Same as QC Acceptance Limits.
ICS	At the beginning of an analytical run.	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spike analytes); ICS-AB: Within ±20 percent of true value.	Terminate analysis; locate and correct problem; reanalyze ICS; reanalyze all samples. If CA fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the ICS.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
LCS - containing all target analytes	One per preparatory batch.	QC acceptance criteria specified by DoD, if available. Refer to **Worksheet #15-11**.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MS	One per preparatory batch per matrix.	Same as LCS.	Examine the project-specific DQOs. If the MS falls outside of DoD criteria, additional QC tests are required to evaluate matrix effects. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MSD	One per preparatory batch per matrix.	Same as MS and refer to **Worksheet #15-11**.	Same as MS.	Analyst	Accuracy/Bias, Precision	Same as QC Acceptance Limits.
Dilution Test	One per preparatory batch.	Five-fold dilution must agree within ±10 percent of the original measurement. Only applicable for samples with concentrations > 50X LOQ.	Perform PDS addition.	Analyst	Accuracy	Same as QC Acceptance Limits.
PDS	When dilution test fails or analyte concentration in all samples < 50X LOD.	Recovery within 75-125 percent (refer to Table B-1 of DoD QSM v. 4.1).	Run all associated samples in the preparatory batch by MSA or, for the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy	Same as QC Acceptance Limits.

[1]DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-11B—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Pore Water, Seep

Analytical Group: Total Mercury and Dissolved Mercury

Analytical Method /SOP Reference: SW-846 Method 7470A SOP103

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch.	No analytes detected > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/Bias, Contamination	Same as QC Acceptance Limits.
LCS	One per preparatory batch.	QC acceptance criteria specified by DoD, if available. Refer to **Worksheet #15-11**.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MS	One per preparatory batch per matrix.	Same as LCS.	Examine the project-specific DQOs. If the MS falls outside of DoD criteria, additional QC tests are required to evaluate matrix effects. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MSD	One per preparatory batch per matrix.	Same as MS and refer to **Worksheet #15-11**.	Same as MS.	Analyst	Accuracy/Bias, Precision	Same as QC Acceptance Limits.

[1]DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-11C—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Pore Water, Seep

Analytical Group: Total Cyanide

Analytical Method /SOP Reference: SW-846 Method 9012B /SOP175/164

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch.	No analytes detected > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/Bias, Contamination	Same as QC Acceptance Limits.
LCS	One per preparatory batch.	QC acceptance criteria specified by DoD, if available. Refer to **Worksheet #15-11**.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MS	One per preparatory batch per matrix.	Same as LCS.	Examine the project-specific DQOs. If the MS falls outside of DoD criteria, the MSA shall be used for the analysis. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy/Bias	Same as QC Acceptance Limits.
MSD	One per preparatory batch per matrix.	Same as MS and refer to **Worksheet #15-11.**	Same as MS.	Analyst	Accuracy/Bias, Precision	Same as QC Acceptance Limits.

[1]DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-12—Laboratory QC Samples Table

Matrix: Groundwater

Analytical Group: Wet Chemistry

Analytical Method /SOP Reference: EPA 300.0, SM4500-S2-F, SM2320B, SW-846 9060, SM3500-Fe-D, RSK175 /SOP145, SOP 153, SOP221, SOP104, SOP143, SOP236

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Chloride, Nitrate, Nitrite, Sulfate (EPA 300.0)						
Method Blank	One per batch.	No target compounds should be >1/2 the LOQ.	If method blank is higher than LOQ, all samples< 10x blank must be reanalyzed.	Analyst/Supervisor	Bias/Contamination	Same as QC Acceptance Limits.
LCS	One per batch.	90-110 percent	If LCS is out high and sample concentrations are < LOQ, no CA. Otherwise all samples must be reanalyzed.	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits.
Laboratory duplicate	Minimum of 10 percent of lab samples unless MSD performed.	RPD<20	Associated data qualified.	Analyst/Supervisor	Precision	Same as QC Acceptance Limits.
Sulfide (SM4500-S2-F)						
Method Blank	One per batch.	No target compounds should be >1/2 the LOQ.	Reanalyze samples.	Analyst/Supervisor	Bias/Contamination	Same as QC Acceptance Limits.
LCS	One per batch.	80-120 percent	Recalibrate and reanalyze samples.	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits.
MS/MSD	One per batch.	80-120 %R and RPD<20 percent	CA will be not taken for samples when recoveries are outside limits and LCS criteria are met. If both the LCS and MS/MSD are unacceptable, reanalyze samples and QC.	Analyst/Supervisor	Accuracy/Bias/Precision	Same as QC Acceptance Limits.
Sample Duplicate	Minimum of 10 percent of lab samples unless MSD performed.	RPD<20	If RPD > 20 percent, sample should be reanalyzed. If still high, result is flagged.	Analyst/Supervisor	Precision	Same as QC Acceptance Limits.
Alkalinity (SM2320B)						
Method Blank	One per batch.	Result < LOQ	Reanalyze samples.	Analyst/Supervisor	Bias/Contamination	Same as QC Acceptance Limits.
LCS	One per batch.	80-120 percent	If LCS is out high and sample concentrations are < LOQ, no CA. Otherwise all samples must be reanalyzed.	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits.
Sample Duplicate	One per batch.	RPD<20	If RPD > 20 percent, sample should be reanalyzed. If still high, result is flagged.	Analyst/Supervisor	Precision	Same as QC Acceptance Limits.
TOC (SW-846 9060)						
Method Blank	One per batch.	No target compounds should be >1/2 the LOQ.	Reanalyze samples	Analyst/Supervisor	Bias/Contamination	Same as QC Acceptance Limits.
LCS	One per batch.	80-120 percent	Recalibrate and reanalyze samples	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits.
MS/MSD	One per batch.	75-125 %R and RPD<20 percent.	CA will be not taken for samples when recoveries are outside limits and LCS criteria are met. If both the LCS and MS/MSD are unacceptable, reanalyze samples and QC.	Analyst/Supervisor	Accuracy/Bias/Precision	Same as QC Acceptance Limits.
Sample Duplicate	Minimum of 10 percent of lab samples unless MSD performed.	RPD<20	If RPD > 20 percent, sample should be reanalyzed. If still high, result is flagged.	Analyst/Supervisor	Precision	Same as QC Acceptance Limits.

SAP Worksheet #28-12—Laboratory QC Samples Table (continued)

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Ferrous Iron (SM3500-Fe-D)						
Method Blank	One per batch.	No target compounds should be >1/2 the LOQ.	Reanalyze samples	Analyst/Supervisor	Bias/Contamination	Same as QC Acceptance Limits.
LCS	One per batch.	80-120 percent	Recalibrate and reanalyze samples	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits.
MS/MSD	One per batch.	75-125 %R and RPD<20 percent.	CA will be not taken for samples when recoveries are outside limits and LCS criteria are met. If both the LCS and MS/MSD are unacceptable, reanalyze samples and QC.	Analyst/Supervisor	Accuracy/Bias/Precision	Same as QC Acceptance Limits.
Methane (RSK-175)						
Method Blank	One per prep batch of twenty or fewer samples of similar matrix; or one per day, whichever comes first.	No analytes detected > 1/2LOQ or >1/10 sample concentration or >1/10 regulatory limit.	Investigate source of contamination. Rerun method blank prior to analysis of samples if possible. Evaluate the samples and associated QC: if blank results are above LOQ, report sample results which are < LOQ or > 10X the blank concentration. Reanalyze blank and samples >LOQ and < 10X the blank	Analyst/Supervisor	Bias/Contamination	Same as QC Acceptance Limits
LCS	One per prep batch of twenty or fewer samples of similar matrix.	80-120 percent	Evaluate and reanalyze if possible. If an MS/MSD was extracted in the same extraction batch and acceptable narrate. If the LCS recoveries are high but the sample results are <LOQ narrate. Otherwise reprep and reanalyze	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits
MS/MSD	One per prep batch of twenty or fewer samples of similar matrix (spike same as LCS).	Same as MS; RPD ≤ 20 percent	CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met unless RPDs indicate obvious extraction/analysis difficulties, then reprep MS/MSD.	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits

SAP Worksheet #29—Project Documents and Records Table

Sample Collection Documents and Records	Onsite Analysis Documents and Records	Offsite Analysis Documents and Records[1]	Data Assessment Documents and Records	Other
• Field Notebooks • Chain-of-Custody Records • Air Bills • Custody Seals • CA Forms • Electronic Data Deliverables • Identification of QC Samples • Meteorological Data from Field (Logging daily weather) • Sampling Instrument Calibration Logs • Sampling Locations and Sampling Plan • Sampling Notes and Drilling Logs	• No onsite analysis will take place other than collecting water quality parameters. These readings will be recorded in field logbooks as they are collected	• Sample Receipt, Chain-of-Custody, and Tracking Records • Standard Traceability Logs • Equipment Calibration Logs • Sample Prep Logs • Run Logs • Equipment Maintenance, Testing, and Inspection Logs • CA Forms • Reported Field Sample Results • Reported Result for Standards, QC Checks, and QC Samples • Instrument printouts (raw data) for Field Samples, Standards, QC Checks, and QC Samples • Data Package Completeness Checklists • Sample disposal records • Extraction/Clean-up Records • Raw Data (stored on disk)	• Fixed Laboratory Audit Checklists • DV Reports • CA Forms • Laboratory QA Plan • Method Detection Limit (MDL) Study Information	

[1] Offsite documents are archived with Iron Mountain Inc. which is headquartered at 745 Atlantic Avenue, Boston, MA 02111.

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SAP Worksheet #30—Analytical Services Table

Matrix	Analytical Group	Sample Locations/ID Number	Analytical Method	Data Package Turnaround Time[2]	Laboratory /Organization (name and address, contact person, and telephone number)	Backup Laboratory /Organization (name and address, contact person, and telephone number)[1]
Surface Soil	VOA	Refer to Worksheet #18	SW-846 8260C	28 Calendar Days	Empirical Laboratories, LLC 621 Mainstream Drive, Suite 270 Nashville, TN 37228 Sonya Gordon ph: (615) 345-1115	TBD
	Pesticides		SW-846 8081B			
	PCBs		SW-846 8082A			
	Explosives		SW-846 8330A & 6850			
	Metals /Cyanide		SW-846 6010C, 7471B, & 9012B			
	pH		SW-846 9045D			
	TOC		Lloyd Kahn			
Subsurface Soil	VOA		SW-846 8260C			
	Pesticides		SW-846 8081B			
	PCBs		SW-846 8082A			
	Explosives		SW-846 8330A & 6850			
	Metals /Cyanide		SW-846 6010C, 7471B, & 9012B			
	pH		SW-846 9045D			
	TOC		Lloyd Kahn			
Sediment	VOA		SW-846 8260C			
	Pesticides		SW-846 8081B			
	PCBs		SW-846 8082			
	Explosives		SW-846 8330A & 6850			
	Metals /Cyanide		SW-846 6010C, 7471B, & 9012B			
	pH		SW-846 9045D			
	TOC		Lloyd Kahn			
	AVS/SEM		EPA 821-R-91-100			
	Grain-size		ASTM D422		Beaver Engineering, Inc. 7378 Cockrill Bend Blvd. Nashville, TN 37209 ph: (615) 350-8124	
Groundwater	VOA		SW-846 8260C		Empirical Laboratories, LLC 621 Mainstream Drive, Suite 270 Nashville, TN 37228 Sonya Gordon ph: (615) 345-1115	
	Explosives		SW-846 8330A & 6850			
	Total Metals/Cyanide		SW-846 6010C, 7470A, & 9012B			
	Dissolved Metals		SW-846 6010C, 7470A			
	Chloride, Nitrite, Nitrate, Sulfate		EPA 300.0			
	Sulfide		SM 4500-S2-F			
	TOC		SW-846 9060			
	Alkalinity		SM 2320B			
	Ferrous Iron		SM3500-Fe D			
	Methane		RSK-175			
Surface Water	VOA		SW-846 8260C			
	Explosives		SW-846 8330A & 6850			
	Total Metals/Cyanide		SW-846 6010C, 7470A, & 9012B			
	Dissolved Metals		SW-846 6010C, 7470A			
Pore Water	VOA		SW-846 8260C			
	Explosives		SW-846 8330A & 6850			
	Total Metals/Cyanide		SW-846 6010C, 7470A, & 9012B			
	Dissolved Metals		SW-846 6010C, 7470A			
Seep	VOA		SW-846 8260C			
	Explosives		SW-846 8330A & 6850			
	Total Metals/Cyanide		SW-846 6010C, 7470A, & 9012B			
	Dissolved Metals		SW-846 6010C, 7470A			

[1] A backup laboratory has not been determined. If circumstances render the subcontracted laboratory unable to perform analytical services, another laboratory will be determined at that time.

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SAP Worksheet #31-1—Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person Responsible for Performing Assessment	Person Responsible for Responding to Assessment Findings	Person Responsible for Identifying and Implementing CA	Person Responsible for Monitoring Effectiveness of CA
Field QA and H&S Audit	Once	Internal	CH2M HILL	Stephen Brand	Brian Wachter, FTL and Field Staff	Stephen Brand	Brett Doerr Mark Orman
Onsite Laboratory Technical Systems Audit (applies to definitive data only)	Laboratory must have a current accreditation from the DoD ELAP which will identify the period of performance and scope of analytical methods. The laboratory must be re-evaluated prior to expiration of period of performance	External	Third Party Accrediting Body	Third Party Accrediting Body (TBD)	Marcia McGinnity, Empirical Laboratories QA Officer	Marcia McGinnity, Empirical Laboratories QA Officer	Anita Dodson, Program Chemist, CH2M HILL

SAP Worksheet #31-2—Corrective Action Form

Person initiating CA ________________________________ **Date** ______________

Description of problem and when identified: ____

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Cause of problem, if known or suspected: ____

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<u>Sequence of CA:</u> (including date implemented, action planned and personnel/data affected) __________

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CA implemented by: ______________________________________ **Date:** ______________________

CA initially approved by: __________________________________ **Date:** ________________

Follow-up date: ____

Final CA approved by: ____________________________________ **Date:** ________________

Information copies to:

<u>Anita Dodson, CH2M HILL Program Chemist</u>

SAP Worksheet #32—Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA Response	Timeframe for Response
Field QA and H&S Audit	Checklist and Written Audit Report	Mary Anderson/ CH2M HILL, PM	Within 1 week of audit	Memorandum	Brian Wachter FTL CH2M HILL Doug Bitterman AQM CH2M HILL	Within 1 week of receipt of CA Form
Onsite Laboratory Technical Systems Audit	Written audit report from DoD Laboratory Accrediting Body	Marcia McGinnity, Empirical Laboratories QA Officer	Within 2 months of audit	Memorandum	DoD Laboratory Accrediting Body (TBD)	Within 2 months of receipt of initial notification

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SAP Worksheet #33—Quality Assurance Management Reports Table

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (title and organizational affiliation)	Report Recipient(s) (title and organizational affiliation)
ERI Report	Post-Field Event	Preliminary draft June 2013	Mary Anderson, PM, CH2M HILL	Stakeholders, see **Worksheet #4**

The ERI Report will address the following:

Summary of project QA/QC requirements/procedures
Conformance of project to UFP-SAP requirements/procedures
Status of project schedule
Deviations from the UFP-SAP and approved amendments that were made
Results of data review activities (how much usable data was generated)
CAs if needed and their effectiveness
Data usability with regards to: precision, accuracy, representativeness, completeness, comparability, and sensitivity
Limitations on data use

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SAP Worksheet #34—Verification (Step I) Process Table

Verification Input	Description	Internal / External	Responsible for Verification (name, organization)
Planning Documents	Evidence of approval and completeness of UFP-SAP.	Internal	PM: Mary Anderson/CH2M HILL
Chain of Custody and shipping forms	Chain-of-custody forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody will be initialed by the reviewer, a copy of the chain-of-custody retained in the site file, and the original and remaining copies taped inside the cooler for shipment. See Chain-of-Custody SOP for further details.	Internal	FTL: Brian Wachter/CH2M HILL Project PDM: Hillary Ott/CH2M HILL
Field Log Notebooks	Field notes will be reviewed to ensure completeness of field data parameters, shipping information, sample collection times, etc. The logbook will also be used to document, explain, and justify all deviations from the approved work plan and UFP-SAP.	Internal	PM: Mary Anderson/CH2M HILL
Sample Login/Receipt	Upon their arrival at the laboratory, the samples will be cross-referenced against the chain-of-custody records. All sample labels will be checked against the chain-of-custody, and any mislabeling will be identified, investigated, and corrected. The samples will be logged in at every storage area and work station required by the designated analyses. Individual analysts will verify the completeness and accuracy of the data recorded on the forms.	Internal	Sample Receipt Personnel Respective Laboratory Personnel
QC Summary Report	A summary of all QC sample results will be verified for completeness once the data is received from the laboratory.	External	Project PDM: Hillary Ott/CH2M HILL

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SAP Worksheet #35—Validation (Steps IIa and IIb) Process Table

Step IIa /IIb[1]	Validation Input	Description	Responsible for Validation (name, organization)
IIa	SOPs	Review field logbooks, laboratory case narratives, data deliverables for compliance to methods and signatures.	FTL: Brian Wachter/CH2M HILL PM: Mary Anderson/CH2M HILL
IIa	QC Results	Establish that all field and lab QC samples were run and compliant with method-required limits as specified in **Worksheets #12 and 28.**	Ward Dickens/CH2M HILL
IIb	QC Results	Verify that QC samples were run and compliant with limits established in the UFP-SAP.	PC: Clairette Campbell /CH2M HILL
IIb	PQLs	Ensure all sample results met the project quantification and action limits specified in **Worksheet #15**.	PC: Clairette Campbell /CH2M HILL
IIb	Raw data	10 percent review of raw data to confirm laboratory calculations.	Ward Dickens/CH2M HILL

[1] IIa=compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.]
IIb=comparison with MPC in the SAP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005]

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SAP Worksheet #36—Analytical Data Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb	Matrix	Analytical Group	Validation Criteria	Data Validator (title and organizational affiliation)
IIa	Surface Soil, Subsurface Soil, Sediment, Groundwater, Surface Water, Pore Water, Seep	VOA, Pesticides, PCBs, and Explosives	Analytical methods and laboratory SOPs as presented in this SAP will be used to evaluate compliance against QA/QC criteria. Should adherence to QA/QC criteria yield deficiencies, data may be qualified. The data qualifiers used are those presented in *Region III Modifications to the National Functional Guidelines for Organic Data Review, Multi-Media, Multi-Concentration*, (September 1994). National Functional Guidelines will not be used for DV; however, the specific qualifiers listed therein may be applied to data should non-conformances against the QA/QC criteria as presented in this SAP be identified.	Validator: Ward Dickens / CH2M HILL
		Total Metals, Cyanide, and Dissolved Metals	Analytical methods and laboratory SOPs as presented in this SAP will be used to evaluate compliance against QA/QC criteria. Should adherence to QA/QC criteria yield deficiencies, data may be qualified. The data qualifiers used are those presented in *Region III Modifications to the National Functional Guidelines for Inorganic Analyses,* (April 1993). National Functional Guidelines will not be used for DV; however, the specific qualifiers listed therein may be applied to data should non-conformances against the QA/QC criteria as presented in this SAP be identified.	Validator: Ward Dickens / CH2M HILL
IIa	Surface Soil, Subsurface Soil, Sediment, Groundwater	Wet Chemistry[1], AVS/SEM, and Grain-size	Data will be reviewed against the analytical methods for outstanding QA/QC issues and anomalies by the laboratory. Issues will be summarized in the case narrative. The CH2M HILL chemist and PM will review the analytical results and case narrative before the data is loaded; any issues will be investigated, and the impact (if any) on data quality or data usability will be discussed with the project team.	PM: Mary Anderson /CH2M HILL PC: Clairette Campbell / CH2M HILL
IIb	Surface Soil, Subsurface Soil, Sediment, Groundwater, Surface Water, Pore Water, Seep	VOA, Pesticides, PCBs, Explosives, Total Metals, Cyanide, Dissolved Metals, Wet Chemistry, AVS/SEM, Grain-size	Refer to PALs in **Worksheet #15** and method calibration and QC criteria in **Worksheets #24 and 28**.	Validator: Ward Dickens / CH2M HILL PM: Mary Anderson /CH2M HILL PC: Clairette Campbell / CH2M HILL

[1] The following analytes are considered to be of the wet chemistry analytical group: TOC, pH, alkalinity, chloride, nitrite, nitrate, sulfate, sulfide, ferrous iron, and methane.

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SAP Worksheet #37—Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

- Non-detected site contaminants will be evaluated to ensure that PQLs in **Worksheet #15** were achieved. If PQLs were achieved and the verification and validation steps yielded acceptable data, then the data is considered usable. If PQLs were not achieved, then the reason will be investigated and documented, and the impact on data usability will be discussed.
- During verification and validation steps, data may be qualified as estimated with the following qualifiers: J, UJ, K, L, or UL. These qualifiers represent minor QC deficiencies which will not affect the usability of the data. When major QC deficiencies are encountered, data will be qualified with an R and in most cases are not considered usable for project decisions.
  - J- Analyte present. Reported value is estimated and may or may not be accurate or precise
  - UJ- Analyte not detected. Quantitation limit (QL) may be inaccurate or imprecise
  - K- Analyte present. Reported value is estimated and may be biased high. Actual value is expected to be lower
  - L- Analyte present. Reported value is estimated and may be biased low. Actual value is expected to be higher
  - UL- Analyte not detected. QL is probably higher.
  - R- Rejected result. Result is not usable.
- Additional qualifiers that may be given by the validator include B, E, N, NJ, and U:
  - B- Not detected more than 5 times than that in an associated blank (10 times for common laboratory contaminants in VOCs)
  - N- Tentative Identification. Consider Present. Special methods may be needed to confirm its presence or absence in future sampling efforts
  - NJ- Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity
  - U- Not Detected
- For statistical comparison, non-detect values will be represented by a concentration equal to one-half the sample reporting limit. For duplicate sample results, the greater of values will be used for project decisions.
- Analytical data will be checked to ensure the values and any qualifiers are appropriately transferred to the electronic database. These checks include comparison of hardcopy data and qualifiers to the electronic data deliverable. Once the data have been uploaded into the electronic database, another check will be performed to ensure all results were loaded accurately.

SAP Worksheet #37—Usability Assessment (continued)

- Field and laboratory precision will be assessed as RPD between the two results.

Deviations from the SAP will be reviewed to assess whether CA is warranted and to assess impacts to achievement of project objectives.

Identify the personnel responsible for performing the usability assessment.

- The PM, PC, and other team members will be responsible for compiling the data. The data will then be presented to the Partnering Team who, as a whole, will evaluate the data usability according to project objectives.

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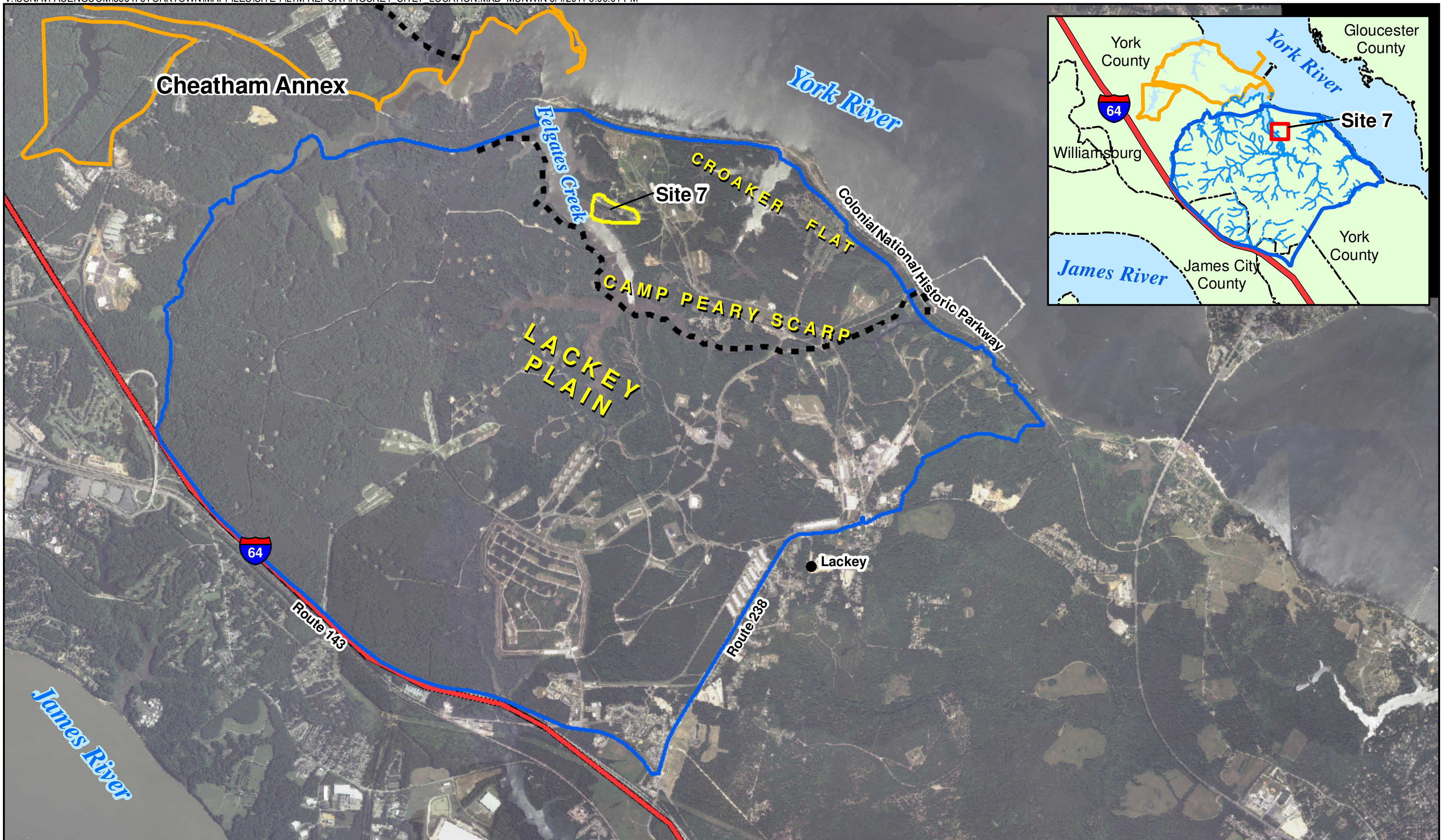
Figures

V:\USNAVFACENGCOM\386475YORKTOWN\MAPFILES\SITE 7\LTM REPORT\FIGURE1_SITE7_LOCATION.MXD MUNWIN 5/4/2011 3:06:01 PM



Legend
- Site 7 Study Area
- Naval Weapons Station Yorktown Boundary
- Cheatham Annex Boundary
- Camp Peary Scarp

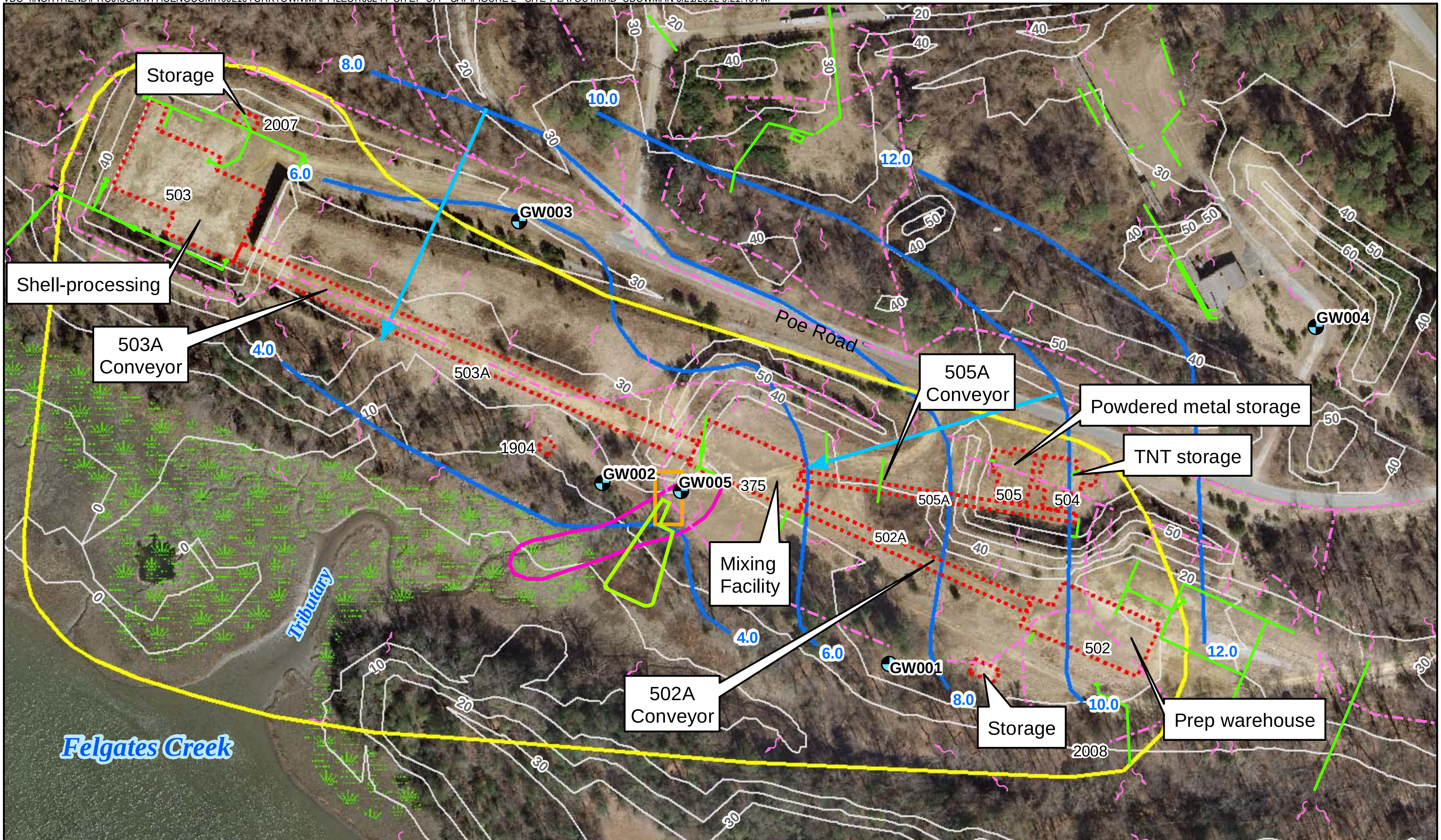
N
W E
S

0 2,500 5,000
Feet

Figure 1
Site 7 Location Map
Naval Weapons Station Yorktown
Yorktown, Virginia

CH2MHILL

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\400210YORKTOWN\MAPFILES\408244_SITE7_UFP_SAP\FIGURE 2 - SITE 7 LAYOUT.MXD CBOWMAN 6/21/2012 9:21:40 AM



Legend

- Yorktown-Eastover Monitoring Well
- Drainage Boundary
- Overland Flow
- Storm Sewer
- Groundwater Contour Line
- Groundwater Flow Direction
- Elevation Contour (10 ft interval)
- Study Area Boundary
- Former Buildings
- Wetlands
- Site Boundary
- Land Use Controls
- Removal Area

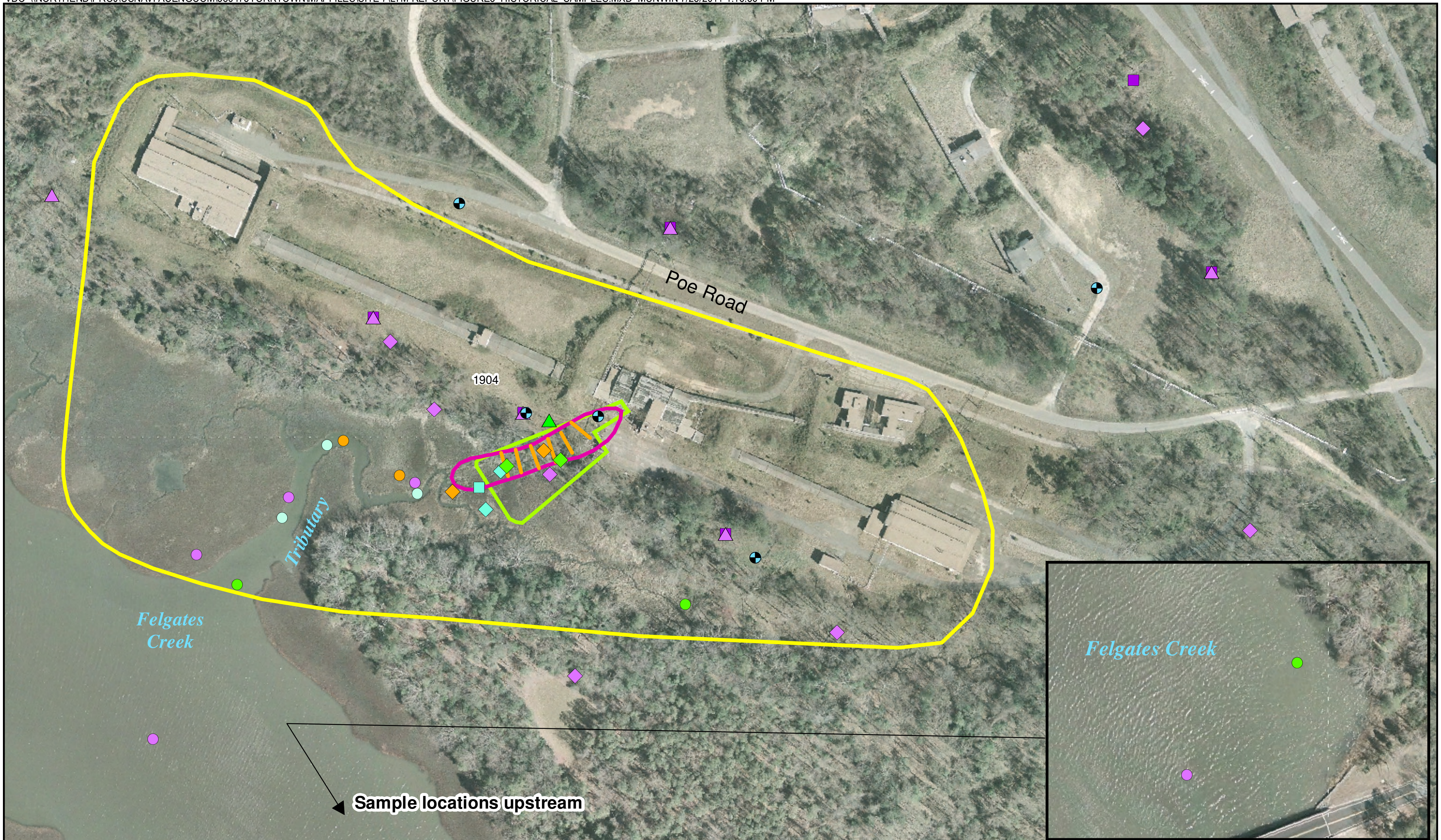
N W E S

0 100 200 Feet

Figure 2
Site 7 Layout Map
Naval Weapons Station Yorktown
Yorktown, Virginia

CH2MHILL

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\386475YORKTOWN\MAPFILES\SITE 7\LTM REPORT\FIGURE3_HISTORICAL_SAMPLES.MXD MUNWIN 7/28/2011 4:16:56 PM



Legend

- Study Area Boundary
- Site Boundary
- Removal Area
- Composite Surface Soil Sample
- Step 1 Confirmation Study Round 1 Surface Soil Sampling Location
- Step 1 Confirmation Study Round 1 Surface Water/Sediment Sampling Location
- Step 1 Confirmation Study Round 2 Surface Soil Sampling Location
- Step 1 Confirmation Study Subsurface Soil Sampling Location
- Round 1 RI Hydropunch Sampling Location
- Round 1 RI Surface Soil Sampling Location
- Round 1 RI Surface Water/Sediment Sampling Location
- Round 2 RI Hydropunch Sampling Location
- Round 2 RI Surface Soil Sampling Location
- Round 2 RI Surface Water/Sediment Sampling Location
- Round 2 RI Subsurface Soil Sampling Location
- Long-Term Monitoring (2000, 2006)
- Long-Term Monitoring (2009)

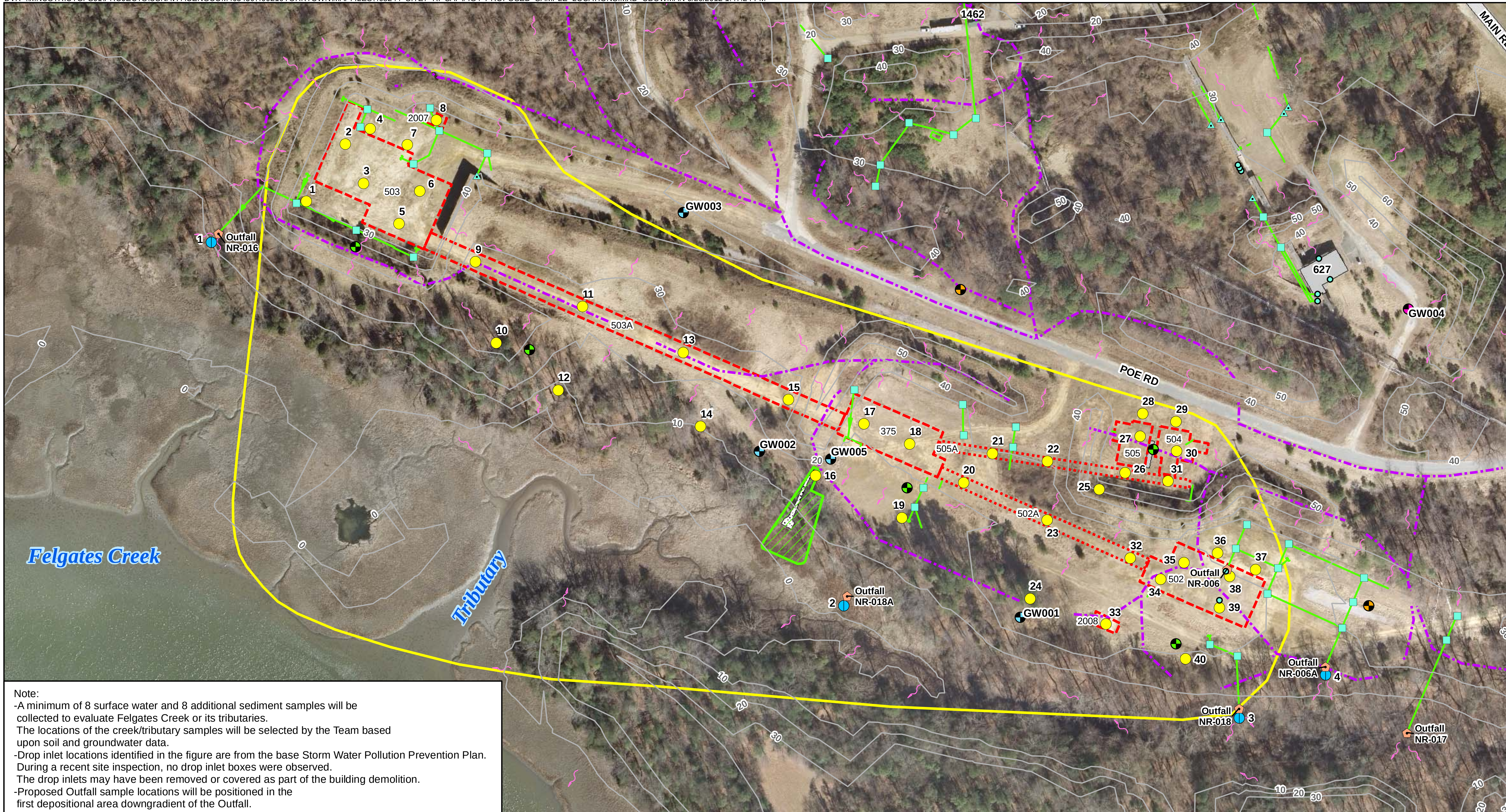
N W E S

0 125 250 Feet

Figure 3
Site 7 Historical Sampling Locations
Naval Weapons Station Yorktown
Yorktown, Virginia

CH2MHILL

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\400210YORKTOWN\MAPFILES\408244_SITE7_RI_SAP\FIG4_PROPOSED_SAMPLE_LOCATIONS.MXD CBOWMAN 6/20/2012 1:47:24 PM



Note:
-A minimum of 8 surface water and 8 additional sediment samples will be collected to evaluate Felgates Creek or its tributaries.
The locations of the creek/tributary samples will be selected by the Team based upon soil and groundwater data.
-Drop inlet locations identified in the figure are from the base Storm Water Pollution Prevention Plan.
During a recent site inspection, no drop inlet boxes were observed.
The drop inlets may have been removed or covered as part of the building demolition.
-Proposed Outfall sample locations will be positioned in the first depositional area downgradient of the Outfall.

Legend

- Proposed Soil Sample Location
- Proposed Sediment Outfall Sample Location
- Existing Yorktown-Eastover Monitoring Well to be sampled
- Existing Yorktown-Eastover Monitoring Well will not be sampled
- Proposed Yorktown-Eastover Monitoring Well*
- Proposed Upgradient Yorktown-Eastover Well
- Building Drain
- Culvert
- Drop Inlet
- Outfall
- Drainage Boundary
- Storm Sewer
- Elevation Contour (10 ft interval)
- Overland Flow
- Study Area
- Former Buildings
- Rip Rap Area
- Site 7 Removal Area (1996)

N
W E
S

0 150 300
Feet

Figure 4
Site 7 Proposed Sample Locations
Naval Weapons Station Yorktown
Yorktown, Virginia

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Appendix A
Field Standard Operating Procedures

Field Filtering

I. Purpose

To provide a general guideline for the field filtering of water samples for dissolved metals analysis.

II. Scope

This is a general discussion of the standard method of field filtering techniques. Operating manuals should be consulted regarding specific procedures.

III. Equipment and Materials

- Peristaltic pump
- C-Flex® tubing or equivalent
- Teflon tubing or equivalent
- 0.45 μm in-line filter cartridge
- Pre-preserved sample container with HNO_3

IV. Procedures and Guidelines

A. Decontaminate reusable equipment before filtration.

B. Prepare the peristaltic pump and the disposable Teflon tubing. The flexible C-Flex tubing goes through the pump head of the pump, and the Teflon tubing (if needed) extends into or from the borehole.

C. Attach the 0.45 μm in-line filter cartridge to the discharge end of the Teflon tubing.

D. Attach the intake end of the Teflon tubing to the groundwater source. This can be:

- Directly from the borehole if pumping with the peristaltic pump through tubing.
- From an unused and pre-cleaned sample container that is used as a temporary reservoir for the sample filtration.
- Directly from the bailer by cutting a small hole in the bailer for the tubing or by attaching the flexible tubing to the end of the bailer.

E. Turn on the peristaltic pump and discard a small amount of the initial sample that flows out of the filter.

F. Direct the discharge end of the C-Flex tubing into the pre-cleaned bottle that will be submitted to the laboratory and pump the remainder of the filtered sample into it.

G. Discard disposable tubing and filter.

H. Repeat for each sample.

V. Attachments

None.

VI. Key Checks and Items

- Use precleaned containers.

Low-Flow Groundwater Sampling from Monitoring Wells

I. Purpose and Scope

This SOP presents general guidelines for the collection of groundwater samples from monitoring wells using low-flow purging and sampling procedures. Operations manuals should be consulted for specific calibration and operating procedures.

II. Equipment and Materials

- Adjustable-rate positive-displacement pump, submersible pump, or peristaltic pump
- Horiba® U-22 or equivalent water quality meters to monitor pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature
- Flow-through cell with inlet/outlet ports for purged groundwater and watertight ports for each probe
- Generator or alternate power source depending on pump type
- Water-level indicator
- Disposable Teflon, Teflon-lined polyethylene tubing or polyethylene tubing for metals and other inorganics
- Plastic sheeting
- Well-construction information
- Calibrated container and stopwatch to determine flow rate
- Sample containers
- In-line disposable 0.45µm filters (QED® FF8100 or equivalent)
- Shipping supplies (labels, coolers, and ice)
- Field book

III. Procedures and Guidelines

A. Setup and Purging

1. Obtain information on well location, diameter(s), depth, and screen interval(s), and the method for disposal of purged water.

2. Calibrate instruments according to manufacturer's instructions.

3. The well number, site, date, and condition are recorded in the field logbook.

4. Plastic sheeting is placed on the ground, and the well is unlocked and opened. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed. To avoid cross-contamination, do not let any downhole equipment touch the ground.

5. All sampling equipment and any other equipment to be placed in the well is cleaned and decontaminated before sampling in accordance with SOP *Decontamination of Personnel and Equipment*.

6. Water level measurements are collected in accordance with the *Water Level Measurements* SOP. **Do not measure the depth to the bottom of the well at this time**; this reduces the possibility that any accumulated sediment in the well will be disturbed. Obtain depth to bottom information from well construction log.

7. Attach and secure the tubing to the low-flow pump. Lower the pump slowly into the well and set it at approximately the middle of the screen. Place the pump intake in the middle of the saturated screen length and should be at least two feet above the bottom of the well to avoid mobilization of any sediment present in the bottom.

8. Insert the measurement probes into the flow-through cell. The purged groundwater is directed through the cell, allowing measurements to be collected before the water contacts the atmosphere.

9. If using a generator, locate it 30 feet downwind from the well to avoid exhaust fumes contaminating the samples.

10. Start purging the well at 0.2 to 0.5 liters per minute. Avoid surging. Purging rates for more transmissive formations could be started at 0.5-liter to 1 liter per minute. The initial field parameters of pH, specific conductance, dissolved oxygen, ORP, turbidity, and temperature of water are measured and recorded in the field logbook.

11. The water level should be monitored during purging, and, ideally, the purge rate should equal the well recharge rate so that there is little or no drawdown in the well (i.e., less than 0.3-foot). The water level should stabilize for the specific purge rate. There should be at least 1 foot of water over the pump intake so there is no risk of the pump suction being broken, or entrainment of air in the sample. Record adjustments in the purge rate and changes in depth to water in the logbook. Purge rates should, if needed, be decreased to the minimum capabilities of the pump (0.1- to 0.2-liter per minute) to avoid affecting well drawdown.

12. During purging, the field parameters are measured frequently (every 5 minutes) until the parameters have stabilized. Field parameters are considered stable when measurements meet the following criteria:

    - pH: within 0.1 pH units

- Specific conductance: within 3 percent
- Dissolved oxygen: within 10 percent
- Turbidity: within 10 percent for values greater than 5 NTU; if 3 turbidity values are less than 5 NTU, consider the values as stabilized
- ORP: within 10 mV
- Temperature: within 3 percent

B. Sample Collection

Once purging is complete the well is ready to sample. The elapsed time between completion of purging and collection of the groundwater sample should be minimized. Typically, the sample is collected immediately after the well has been purged, but this is also dependent on well recovery.

Samples will be placed in sample containers that have been cleaned to laboratory standards and are preserved in accordance with the analytical method. The containers are typically pre-preserved, if required.

VOC samples are normally collected first and directly into pre-preserved sample containers.

During purging and sampling, the centrifugal/peristaltic pump tubing must remain filled with water to avoid aeration of the groundwater. It is recommended that ¼ or 3/8 inch inside diameter tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, collect non-VOC dissolved gasses samples first, then increase flow rate slightly until water completely fills the tubing and collect the VOC/dissolved gases samples. Record new flow rate and drawdown depth.

The steps to be followed for sample collection are as follows:

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.
2. The sample is slowly poured from the bailer or discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs.
3. Inorganics, including metals, may be collected and preserved in the filtered form as well as the unfiltered form. Disposable in-line filters (0.45 micron filter), connected to the end of the sample tubing,, are typically used for field filtration. Samples are field filtered as the water is being placed into the sample container. If a bailer is used, filtration may be driven by a peristaltic pump.

4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to the top with a positive meniscus.
5. The bottle is capped and clearly labeled.
6. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.
7. Nondedicated equipment is cleaned and decontaminated in accordance with the *Decontamination of Personnel and Equipment* SOP.

The following information, at a minimum, will be recorded in the log book:

1. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; time and date; sampler's identity)
2. Sample source and source description
3. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), volume of water purged prior to sampling, number of well volumes purged, and field parameter measurements
4. Sample disposition (preservative; laboratory name, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)
5. Additional remarks

C. Additional remarks

1. If the well goes dry during purging, wait until it recovers sufficiently to remove the required volumes to sample all parameters. It may be necessary to return periodically to the well but a particular sample (e.g., large amber bottles for semivolatile analysis) should be filled at one time rather than over the course of two or more visits to the well.
2. Disposable tubing is disposed of with PPE and other site trash.

IV. Attachments

White paper on reasons and rationale for low-flow sampling.

V. Key Checks and Preventative Maintenance

- The drawdown in the well should be minimized as much as possible (preferably no more than 0.5-foot to 1 foot) so that natural groundwater-flow conditions are maintained as closely as possible.
- The highest purging rate should not exceed 1 liter per minute. This is to keep the drawdown minimized.

- Stirring up of sediment in the well should be avoided so that turbidity containing adsorbed chemicals is not suspended in the well and taken in by the pump.

- Overheating of the pump should be avoided to minimize the potential for losing VOCs through volatilization.

- Keep the working space clean with plastic sheeting and good housekeeping.

- Maintain field equipment in accordance with the manufacturer's recommendations. This will include, but is not limited to:

    - Inspect sampling pump regularly and replace as warranted

    - Inspect quick-connects regularly and replace as warranted

    - Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

Attachment to the SOP on Low-Flow Sampling Groundwater Sampling from Monitoring Wells

White Paper on Low-Flow Sampling

EPA recommends low-flow sampling as a means of collecting groundwater samples in a way that minimizes the disturbance to the natural groundwater flow system and minimizes the introduction of contamination into the samples from extraneous sources. The following are details about these issues.

When a pump removes groundwater from the well at the same rate that groundwater enters the well through the screen, the natural groundwater-flow system around the well experiences a minimum of disturbance. Some disturbance is bound to occur because you are causing groundwater to flow to the well in a radial fashion that otherwise would have flowed past it. However, the resulting low-flow sample provides the most-representative indication we can get of groundwater quality in the immediate vicinity of the well.

Normally, when a well is pumped at an excessive rate that drops the water level in the well below the water level in the aquifer, the water cascades down the inside of the well screen when it enters the well. The turbulence from this cascading causes gases such as oxygen and carbon dioxide to mix with the water in concentrations that are not representative of the native groundwater and are higher than expected. This causes geochemical changes in the nature of the water that can change the concentrations of some analytes, particularly metals, in the groundwater sample, not mention it's effect on the dissolved oxygen levels that then will be measured in the flow-through cell. Such turbulence also may cause lower-than-expected concentrations of volatile organic compounds due to volatilization.

For wells in which the water level is above the top of the screen, the water up in the riser is out of the natural circulation of the groundwater and, therefore, can become stagnant. This stagnant water is no longer representative of natural groundwater quality because its pH, dissolved-oxygen content, and other geochemical characteristics change as it contacts the air in the riser. If we minimize the drawdown in the well when we pump, then we minimize the amount of this stagnant water that is brought down into the well screen and potentially into the pump. As a result, a more-representative sample is obtained.

Typically, wells contain some sediment in the bottom of the well, either as a residue from development that has settled out of the water column or that has sifted through the sand pack and screen since the well was installed. This sediment commonly has adsorbed on it such analytes as metals, SVOCs, and dioxins that normally would not be dissolved in the groundwater. If these sediments are picked up in the groundwater when the well is disturbed by excessive pumping, they can:

- Make filtering the samples for metals analysis more difficult
- Add unreasonably to the measured concentration of SVOCs and other organic compounds

The SOP for low-flow sampling has been modified recently and should be consulted for additional information about low-flow sampling and ways of dealing with wells in which the water level cannot be maintained at a constant level.

STANDARD OPERATING PROCEDURE

General Guidance for Monitoring Well Installation

I. Purpose

To provide site personnel with a review of the well installation procedures that will be performed. These procedures are to be considered general guidelines only and are in no way intended to supplement or replace the contractual specifications in the driller's subcontract.

II. Scope

Monitoring well installations are planned for shallow and/or deep unconsolidated aquifers and/or for bedrock aquifers. The SOPs *Installation of Shallow Monitoring Wells, Installation of Surface-Cased Monitoring Wells, Installation of Bedrock Monitoring Wells,* and *Installation of Monitoring Wells Using Sonic Drilling* provide more specifics.

III. Equipment and Materials

1. Drilling rig (hollow stem auger, sonic, air hammer, air rotary, or mud rotary)
2. Well-construction materials (i.e., surface casing, screens, riser, casing, caps, bottom plugs, centering guides, sand, bentonite, grout, and surface-finish materials)
3. Development equipment

IV. Procedures and Guidelines

1. Wells will be installed in accordance with standard EPA procedures. Note that USEPA Region III requires any well penetrating a confining layer to be double-cased.
2. The threaded connections will be water-tight.
3. Well screens generally will be constructed of 10-slot or 20-slot Schedule 40 PVC and will be 5 to 10 feet in length depending on saturated thickness of unconsolidated sediments. The exact slot size and length will be determined by the field team supervisor. Stainless steel may be required under certain contaminant conditions.
4. Stick-up wells will be surrounded by four concrete-filled guard posts at least 2 inches in diameter.

5. A record of the finished well construction will be compiled.

6. All soils and liquids generated during well installations will be drummed for proper disposal.

Monitoring Well Installation

- 2″ monitoring wells in unconsolidated materials will be installed in at least 6-inch-diameter boreholes to accommodate well completion materials in designated locations.

- All monitoring wells penetrating a confining layer will be surface-cased from the ground surface to approximately 5 feet into the confining layer. Exceptions to this may be allowed under certain circumstances (e.g., evidence of significant natural gaps in the confining layer).

- Monitoring wells in unconsolidated materials will be constructed of 2-inch-diameter, factory manufactured, flush-jointed, Schedule 40 PVC (or stainless steel) screen with threaded bottom plug and riser.

- Screens will be filter packed with a properly sized and graded, thoroughly washed, sound, durable, well-rounded basalt or siliceous sand. When using hollow-stem augers, the filter pack will be installed by slowly pouring the sand into the annular space while simultaneously raising the augers and using a weighted tape to sound for the sand surface. For rotary-drilled wells, the height of the sand pack also will be sounded with a weighted tape.

- The primary filter sand pack (typically Morie #00 or DSI #1 for a 10-slot screen) will extend from 1 to 2 feet below the base to 2 feet above the top of the screen; filter pack will be allowed to settle before final measurement is taken. For wells deeper than 30 feet, the filter pack will be placed using a tremie pipe and flowing water.

- A secondary filter sand pack (typically a fine sand seal) 1-foot thick may be placed above the primary sand pack.

- Annular well seals will consist of 2 feet of pelletized, chip, or granular bentonite clay placed above the filter pack. If necessary the pellets will be hydrated using potable water. For wells installed using hollow-stem augers, the bentonite will be poured into the annular space while slowly raising the augers and sounding for the top of the bentonite with a weighted tape. A high-solids bentonite slurry using powdered bentonite introduced with a side-discharging tremie pipe will be used for the bentonite seals in wells greater than 30 feet deep. For rotary-drilled wells, the height of the well seal also will be sounded with a weighted tape. High-solids slurries will have solids content of at least 20 percent.

- The top of the annular seal will be measured after the bentonite seal has been allowed to hydrate and before the grout is applied. The seal will be allowed to hydrate for at least 30 minutes before work in the well continues.

- The annular space above the bentonite seal will be filled to grade with a bentonite-cement slurry grout mixture.
- The grout mixture consists of 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 6 pounds of bentonite added per bag of cement to reduce shrinkage.
- The grout mix will be carefully applied to avoid disturbing the bentonite seal; the method of grout placement must force grout from the top of the bentonite seal to ground surface.
- After allowing the grout to settle and set up overnight, additional grout will be added to maintain grade.
- A protective steel casing equipped with keyed alike locking caps will be grouted in place for each new well; the casing will extend at least 2 feet above grade and 3 feet below grade, and will be painted a bright color.

Well Development

- New monitoring wells will be developed after the well has been completely installed and the grout has hardened (at least 24 hours)
- The well will be developed by surging and pumping.
- Equipment placed in the well will be decontaminated before use.
- If information is available, begin developing in the least-contaminated well first.
- Development will include surging the well by either abruptly stopping flow and allowing water in the well column to fall back into the well or through the use of a surge block that is slightly smaller in diameter than the well casing inner diameter.
- Pipes and pumps must not be fitted with foot valves or other devices that might inhibit the return flow of water to the well.
- Surging should continue throughout the development process.
- The air-lift method may be used to pump materials out of the well. The air compressor will be fitted with filters to remove all oil and the air lift hose used will be made of inert materials.
- Well development will continue until the water produced is free of turbidity, sand, and silt. A Horiba-U22 meter, YSI meter with separate Hanna turbidity meter, or equivalent should be used to determine when the turbidity is low and parameters have stabilized.
- Development water will be considered hazardous and placed in sealed 55-gallon U.S. DOT approved steel drums. CH2M HILL will label and date the drums as pending analysis, and transport the drums to a designated site for storage.

V. Attachments

None.

VI. Key Check and Items

- Ensure that all equipment is properly decontaminated as needed.
- Only new, sealed materials (e.g., screens, risers, and sand) will be used in constructing the well.
- Care shall be taken when making downhole measurements to ensure that proper heights of sand, seal, and grout are achieved.

STANDARD OPERATING PROCEDURE

Installation of Shallow Monitoring Wells

I. Purpose and Scope

The purpose of this guideline is to describe methods for drilling and installation of shallow monitoring wells and piezometers in unconsolidated or poorly consolidated materials using hollow stem augers, air rotary, or mud rotary. Installing monitoring wells in unconsolidated materials using sonic drilling is discussed in SOP *Installation of Monitoring Wells Using Sonic Drilling.* Methods for drilling and installing bedrock monitoring wells and deep, surface-cased wells in unconsolidated materials are presented in SOPs *Installation of Bedrock Monitoring Wells* and *Installation of Surface-Cased Monitoring Wells,* respectively.

II. Equipment and Materials

Drilling

- Drilling rig (hollow stem auger, air rotary or mud rotary) and associated tools and equipment

Well Riser/Screen and Associated Materials

- Polyvinyl chloride (PVC), Schedule 40, minimum 2-inch ID, flush-threaded riser; alternatively, stainless-steel riser
- PVC, Schedule 40, minimum 2-inch ID, flush-threaded, factory slotted screen; alternatively, stainless-steel screen
- PVC bottom cap, threaded to match the well screen; alternatively, stainless steel
- PVC or stainless-steel centering guides (if used)
- Above-grade well completion: PVC well cap, threaded or push-on type, vented
- Flush-mount well completion: PVC well cap, locking, leak-proof seal
- Stainless steel to be used as appropriate

Sand

- Clean silica sand, provided in factory-sealed bags, well-rounded, containing no organic material, anhydrite, gypsum, mica, or calcareous material; primary (coarse – e.g., Morie #1) filter pack, and secondary (fine sand seal) filter pack. Grain size determined based on sediments observed during drilling.

Bentonite

- Pure, additive-free bentonite pellets or chips
- Pure, additive-free powdered bentonite
- Coated bentonite pellets; coating must biodegrade within 7 days
- Cement-Bentonite Grout: proportion of 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 6 pounds of bentonite added per bag of cement to reduce shrinkage.

Protective Casing

- Above-grade well completion: 6-inch minimum ID black iron steel pipe with locking cover, diameter at least 2 inches greater than the well casing, painted with epoxy paint for rust protection; heavy duty lock; protective posts if appropriate
- Flush-mount well completion: Morrison 9-inch or 12-inch 519 manhole cover, or equivalent; rubber seal to prevent leakage; locking cover inside of road box

Well Development

- Surge block
- Well-development pump and associated equipment
- Calibrated meters to ensure pH, temperature, specific conductance, ORP, and dissolved oxygen of development water
- Containers (e.g., DOT-approved 55-gallon drums) for water produced from well.

III. Procedures and Guidelines

A. Drilling Method

Typically, continuous-flight hollow-stem augers with a minimum 4.25-inch inside diameter (ID) will be used to drill shallow monitoring well boreholes for 2-inch diameter monitoring wells. Alternatively, air or mud rotary may be used.

The bit of the auger is placed at the ground surface and then turned with the drilling rig. To collect split spoon samples, the auger is advanced to the top of the sampling depth, and the split-spoon sample is collected from below the auger head. The split spoon is advanced through repeated blows from a 140- or 300-pound hammer dropped from a height of 30 inches. Thin-walled tube samplers are advanced by pressing down on the rods with the weight of the drilling rig. Split-spoon samples may be collected at selected intervals for chemical analysis and/or lithologic classification. Soil sampling procedures are detailed in SOPs *Soil Boring Sampling – Split Spoons* and *Soil Sampling*.

The use of water to assist in hollow-stem auger drilling for monitoring well installation will be avoided, unless required for such conditions as running sands.

Hollow-stem augers, drilling bits, rods, split-spoon samplers, and other downhole drilling tools will be properly decontaminated prior to the initiation of drilling activities and between each borehole location. Split-spoon samplers and other downhole soil sampling equipment will also be properly decontaminated before and after each use. SOP *Decontamination of Drill Rigs and Equipment* details proper decontamination procedures.

Drill cuttings and decontamination fluids generated during well drilling activities will be contained according to the procedures detailed in the SOP *Disposal of Waste Fluids and Solids* and the Investigation Derived Waste Management Plan (IDWMP).

Air or mud rotary drilling may be used instead of hollow-stem augers. The use of added mud should be kept to a minimum.

B. Monitoring-Well Installation

Shallow monitoring wells will be constructed inside the hollow-stem augers, once the borehole has been advanced to the desired depth, or in the mudded borehole once the drilling rods have been withdrawn. If the borehole has been drilled to a depth greater than that at which the well is to be set, the borehole will be backfilled with bentonite pellets or chips or a bentonite-cement slurry to a depth approximately 1 foot below the intended well depth. Approximately 1 foot of clean sand will be placed on top of the bentonite to return the borehole to the proper depth for well installation.

The appropriate lengths of well screen, nominally 10 feet (with bottom cap), and casing will be joined watertight and lowered inside the augers to the bottom of the borehole. Centering guides, if used, will be placed at the bottom of the screen and above the interval in which the bentonite seal is placed.

Selection of the filter pack and well screen intervals for the shallow monitoring wells shall be made in the field.

A primary sand pack consisting of clean Morie No. 00 (or DSI No.1) silica sand for 10-slot screen and Morie No. 01 (or DSI No.2) for 20-slot screen silica sand will be placed around the well screen. The sand will be placed into the borehole at a uniform rate, in a manner that will allow even placement of the sand pack. The augers will be raised gradually during sand pack installation to avoid caving of the borehole wall; at no time will the augers be raised higher than the top of the sand pack during installation. During placement of the sand, the position of the top of the sand will be continuously sounded. The primary sand pack will be extended from the bottom of the borehole to a minimum height of 2 feet above the top of the well screen. A secondary, finer-grained (fine sand seal), sand pack will be installed for a minimum of 1 foot above the coarse sand pack. Heights of the coarse and fine sand packs and bentonite seal may be modified in the field to account for a shallow water table and a small saturated thickness of the surficial aquifer.

A bentonite seal at least 2 feet thick will be placed above the sand pack. The seal will be placed into the borehole in a manner that will prevent bridging. The position of the top of the bentonite seal will be verified using a weighted tape measure. If all or a portion of the bentonite seal is above the water table, clean water will be added to hydrate the bentonite. A hydration period of at least 30 minutes will be required following installation of the bentonite seal.

Above the bentonite seal, an annular seal of cement-bentonite grout will be placed. The cement-bentonite grout will be installed continuously in one operation from the bottom of the space to be grouted to the ground surface through a tremie pipe. The tremie pipe must be plugged at the bottom and have small openings along the sides of the bottom 1-foot length of pipe. This will allow the grout to diffuse laterally into the borehole and not disturb the bentonite pellet seal.

C. Well Completion

For monitoring wells that will be completed above-grade, a locking steel protective casing set in a concrete pad will be installed. The steel protective casing will extend at least 3 feet into the ground and 2 feet above ground but should not penetrate the bentonite seal. The concrete pad will be square, approximately 2 feet per side (unless otherwise specified in the project plans), and poured into wooden forms. The concrete will be sloped away from the protective casing.

Guard posts may be installed in high-traffic areas for additional protection. Four steel guard posts will be installed around the protective casing Guard posts would be concrete-filled, at least 2 inches in diameter, and would extend at least 2 feet into the ground and 3 feet above the ground. The protective casing and guard posts will be painted with an epoxy paint to prevent rust.

For monitoring wells with flush-mount completions, Morrison 9-inch or 12-inch 519 manhole cover or equivalent, with a rubber-sealed cover and drain will be installed. The top of the manhole cover will be positioned approximately 1 inch above grade. A square concrete pad, approximately 2 feet per side (unless otherwise specified in the project plans), will be installed as a concrete collar surrounding the road box cover, and will slope uniformly downward to the adjacent grade. The road box and installation thereof will be of sufficient strength to withstand normal vehicular traffic.

Concrete pads installed at all wells will be a minimum of 6 inches below grade. The concrete pad will be 12 inches thick at the center and taper to 6-inch thick at the edge. The surface of the pad should slope away from the protective casing to prevent water from pooling around the casing. Protective casing, guard posts, and flush mounts will be installed into this concrete.

Each well will be properly labeled on the exterior of the locking cap or protective casing with a metal stamp indicating the permanent well number.

D. Well Development

Well development will be accomplished using a combination of surging throughout the well screen and pumping, until the physical and chemical parameters of the discharge water that are measured in the field have stabilized and the turbidity of the discharge water is substantially reduced. Fine-grained materials in the surficial aquifer at the site may not allow low turbidity results to be achieved.

The surging apparatus will include a surge block. Well development will begin by surging the well screen, starting at the bottom of the screen and proceeding upwards, throughout the screened zone. Following surging, the well will be pumped to remove the fine materials that have been drawn into the well. During pumping, measurements of pH, temperature, and specific conductance will be recorded.

Development will continue by alternately surging and pumping until the discharge water is free from sand and silt, the turbidity is substantially reduced, and the pH, temperature, and specific conductance have stabilized at regional background levels, based on historical data. Development will continue for a minimum of 30 minutes and until the water removed from the well is as clear of turbidity as practicable.

Well development equipment will be decontaminated prior to initial use and after the development of each well. Decontamination procedures are detailed in SOP *Decontamination of Personnel and Equipment*. Water generated during well development will be contained and managed as detailed in the SOP *Disposal of Waste Fluids and Solids* and the Investigation Derived Waste Management Plan.

IV. Attachments

Schematic diagram of shallow monitoring-well construction (MWSingleDiag.xls)

STANDARD OPERATING PROCEDURE

Logging of Soil Borings

I. Purpose and Scope

This SOP provides guidance to obtain accurate and consistent descriptions of soil characteristics during soil-sampling operations. The characterization is based on visual examination and manual tests, not on laboratory determinations.

II. Equipment and Materials

- Indelible pens
- Tape measure or ruler
- Field logbook
- Spatula
- HCl, 10 percent solution
- Squirt bottle with water
- Rock- or soil-color chart (e.g., Munsell)
- Grain-size chart
- Hand lens
- Unified Soil Classification System (USCS) index charts and tables to help with soil classification (attached)

III. Procedures and Guidelines

This section covers several aspects of soil characterization: instructions for completing the CH2M HILL soil boring log Form D1586 (attached), field classification of soil, and standard penetration test procedures.

A. Instructions for Completing Soil Boring Logs

Soil boring logs will be completed in the field log books or on separate soil boring log sheets. Information collected will be consistent with that required for Form D1586 (attached), a standard CH2M HILL form (attached), or an equivalent form that supplies the same information.

The information collected in the field to perform the soil characterization is described below.

Field personnel should review completed logs for accuracy, clarity, and thoroughness of detail. Samples also should be checked to see that information is correctly recorded on both jar lids and labels and on the log sheets.

B. **Heading Information**

Boring/Well Number. Enter the boring/well number. A numbering system should be chosen that does not conflict with information recorded for previous exploratory work done at the site. Number the sheets consecutively for each boring.

Location. If station, coordinates, mileposts, or similar project layout information is available, indicate the position of the boring to that system using modifiers such as "approximate" or "estimated" as appropriate.

Elevation. Elevation will be determined at the conclusion of field activities through a survey.

Drilling Contractor. Enter the name of the drilling company and the city and state where the company is based.

Drilling Method and Equipment. Identify the bit size and type, drilling fluid (if used), and method of drilling (e.g., rotary, hollow-stem auger). Information on the drilling equipment (e.g., CME 55, Mobile B61) also is noted.

Water Level and Date. Enter the depth below ground surface to the apparent water level in the borehole. The information should be recorded as a comment. If free water is not encountered during drilling or cannot be detected because of the drilling method, this information should be noted. Record date and time of day (for tides, river stage) of each water level measurement.

Date of Start and Finish. Enter the dates the boring was begun and completed. Time of day should be added if several borings are performed on the same day.

Logger. Enter the first and last name.

C. **Technical Data**

Depth Below Surface. Use a depth scale that is appropriate for the sample spacing and for the complexity of subsurface conditions.

Sample Interval. Note the depth at the top and bottom of the sample interval.

Sample Type and Number. Enter the sample type and number. SS-1 = split spoon, first sample. Number samples consecutively regardless of type. Enter a sample number even if no material was recovered in the sampler.

Sample Recovery. Enter the length to the nearest 0.1-foot of soil sample recovered from the sampler. Often, there will be some wash or caved material above the sample; do not include the wash material in the measurement. Record soil recovery in feet.

Standard Penetration Test Results. In this column, enter the number of blows required for each 6 inches of sampler penetration and the "N" value, which is the sum of the blows in the middle two 6-inch penetration intervals. A typical standard penetration test involving successive blow counts of 2, 3, 4, and 5 is recorded as 2-3-4-5 and (7). The standard penetration test is terminated if the sampler encounters refusal. Refusal is a penetration of less than 6 inches with a blow count of 50. A partial penetration of 50 blows for 4 inches is recorded as 50/4 inches. Penetration by the weight of the slide hammer only is recorded as "WOH."

Samples should be collected using a 140-pound hammer and 2-inch diameter split spoons. Samples may be collected using direct push sampling equipment. However, blow counts will not be available. A pocket penetrometer may be used instead to determine relative soil density of fine grained materials (silts and clays).

Sample also may be collected using a 300-pound hammer or 3-inch-diameter split-spoon samples at the site. However, use of either of these sample collection devices invalidates standard penetration test results and should be noted in the comments section of the log. The 300-pound hammer should only be used for collection of 3-inch-diameter split-spoon samples. Blow counts should be recorded for collection of samples using either a 3-inch split-spoon, or a 300-pound hammer. An "N" value need not be calculated.

Soil Description. The soil classification should follow the format described in the "Field Classification of Soil" subsection below.

Comments. Include all pertinent observations (changes in drilling fluid color, rod drops, drilling chatter, rod bounce as in driving on a cobble, damaged Shelby tubes, and equipment malfunctions). In addition, note if casing was used, the sizes and depths installed, and if drilling fluid was added or changed. You should instruct the driller to alert you to any significant changes in drilling (changes in material, occurrence of boulders, and loss of drilling fluid). Such information should be attributed to the driller and recorded in this column.

Specific information might include the following:

- The date and the time drilling began and ended each day
- The depth and size of casing and the method of installation
- The date, time, and depth of water level measurements
- Depth of rod chatter
- Depth and percentage of drilling fluid loss
- Depth of hole caving or heaving
- Depth of change in material
- Health and safety monitoring data
- Drilling interval through a boulder

D. Field Classification of Soil

This section presents the format for the field classification of soil. In general, the approach and format for classifying soils should conform to ASTM D 2488, Visual-Manual Procedure for Description and Identification of Soils (attached).

The Unified Soil Classification System is based on numerical values of certain soil properties that are measured by laboratory tests. It is possible, however, to estimate these values in the field with reasonable accuracy using visual-manual procedures (ASTM D 2488). In addition, some elements of a complete soil description, such as the presence of cobbles or boulders, changes in strata, and the relative proportions of soil types in a bedded deposit, can be obtained only in the field.

Soil descriptions should be precise and comprehensive without being verbose. The correct overall impression of the soil should not be distorted by excessive emphasis on insignificant details. In general, similarities rather than differences between consecutive samples should be stressed.

Soil descriptions must be recorded for every soil sample collected. The format and order for soil descriptions should be as follows:

1. Soil name (synonymous with ASTM D 2488 Group Name) with appropriate modifiers. Soil name should be in all capitals in the log, for example "POORLY-GRADED SAND."
2. Group symbol, in parentheses, for example, "(SP)."
3. Color, using Munsell color designation
4. Moisture content
5. Relative density or consistency
6. Soil structure, mineralogy, or other descriptors

This order follows, in general, the format described in ASTM D 2488.

E. Soil Name

The basic name of a soil should be the ASTM D 2488 Group Name on the basis of visual estimates of gradation and plasticity. The soil name should be capitalized.

Examples of acceptable soil names are illustrated by the following descriptions:

- A soil sample is visually estimated to contain 15 percent gravel, 55 percent sand, and 30 percent fines (passing No. 200 sieve). The fines are estimated as either low or highly plastic silt. This visual classification is SILTY SAND WITH GRAVEL, with a Group Symbol of (SM).
- Another soil sample has the following visual estimate: 10 percent gravel, 30 percent sand, and 60 percent fines (passing the No. 200 sieve). The fines are estimated as low plastic silt. This visual classification is SANDY SILT. The gravel portion is not included in the soil name because the gravel portion was estimated as less than 15 percent. The Group Symbol is (ML).

The gradation of coarse-grained soil (more than 50 percent retained on No. 200 sieve) is included in the specific soil name in accordance with ASTM D 2488. There is no need to further document the gradation. However, the maximum size and angularity or roundness of gravel and sand-sized particles should be recorded. For fine-grained soil (50 percent or more passing the No. 200 sieve), the name is modified by the appropriate plasticity/elasticity term in accordance with ASTM D 2488.

Interlayered soil should each be described starting with the predominant type. An introductory name, such as "Interlayered Sand and Silt," should be used. In addition, the relative proportion of each soil type should be indicated (see Table 1 for example).

Where helpful, the evaluation of plasticity/elasticity can be justified by describing results from any of the visual-manual procedures for identifying fine-grained soils, such as reaction to shaking, toughness of a soil thread, or dry strength as described in ASTM D 2488.

F. Group Symbol

The appropriate group symbol from ASTM D 2488 must be given after each soil name. The group symbol should be placed in parentheses to indicate that the classification has been estimated.

In accordance with ASTM D 2488, dual symbols (e.g., GP-GM or SW-SC) can be used to indicate that a soil is estimated to have about 10 percent fines. Borderline symbols (e.g., GM/SM or SW/SP) can be used to indicate that a soil sample has been identified as having properties that do not distinctly place the soil into a specific group. Generally, the group name assigned to a soil with a borderline symbol should be the group name for the first symbol. The use of a borderline symbol should not be used indiscriminately. Every effort should be made to first place the soil into a single group.

G. Color

The color of a soil must be given. The color description should be based on the Munsell system. The color name and the hue, value, and chroma should be given.

H. Moisture Content

The degree of moisture present in a soil sample should be defined as dry, moist, or wet. Moisture content can be estimated from the criteria listed on Table 2.

I. Relative Density or Consistency

Relative density of a coarse-grained (cohesionless) soil is based on N-values (ASTM D 1586 [attached]). If the presence of large gravel, disturbance of the sample, or non-standard sample collection makes determination of the in situ relative density or consistency difficult, then this item should be left out of the description and explained in the Comments column of the soil boring log.

Consistency of fine-grained (cohesive) soil is properly based on results of pocket penetrometer or torvane results. In the absence of this information, consistency can be estimated from N-values. Relationships for determining relative density or consistency of soil samples are given in Tables 3 and 4.

J. Soil Structure, Mineralogy, and Other Descriptors

Discontinuities and inclusions are important and should be described. Such features include joints or fissures, slickensides, bedding or laminations, veins, root holes, and wood debris.

Significant mineralogical information such as cementation, abundant mica, or unusual mineralogy should be described.

Other descriptors may include particle size range or percentages, particle angularity or shape, maximum particle size, hardness of large particles, plasticity of fines, dry strength, dilatancy, toughness, reaction to HCl, and staining, as well as other information such as organic debris, odor, or presence of free product.

K. Equipment and Calibration

Before starting the testing, the equipment should be inspected for compliance with the requirements of ASTM D 1586. The split-barrel sampler should measure 2-inch or 3-inch O.D., and should have a split tube at least 18 inches long. The minimum size sampler rod allowed is "A" rod (1-5/8-inch O.D.). A stiffer rod, such as an "N" rod (2-5/8-inch O.D.), is required for depths greater than 50 feet. The drive weight assembly should consist of a 140-pound or 300-pound hammer weight, a drive head, and a hammer guide that permits a free fall of 30 inches.

IV. Attachments

Soil Boring Log (Sample Soil Boring Log.xls)

CH2M HILL Form D1586 and a completed example (Soil_Log_Examp.pdf)

ASTM D 2488 *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)* (ASTM D2488.pdf)

ASTM 1586 *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils* (ASTM D1586.pdf)

Tables 1 through 4 (Tables 1-4.pdf)

V. Key Checks and Preventive Maintenance

- Check entries to the soil-boring log and field logbook in the field; because the samples will be disposed of at the end of fieldwork, confirmation and corrections cannot be made later.
- Check that sample numbers and intervals are properly specified.
- Check that drilling and sampling equipment is decontaminated using the procedures defined in SOP *Decontamination of Drilling Rigs and Equipment*.

STANDARD OPERATING PROCEDURE

Shallow Soil Sampling

I. Purpose

To provide general guidelines for the collection and handling of surface soil samples during field operations.

II. Scope

The method described for surface soil sampling is applicable for loosely packed earth and is used to collect disturbed-soil samples.

III. Equipment and Materials

- Sample jars.
- A hand auger or other device that can be used to remove the soil from the ground. Only stainless steel, Teflon, or glass materials should be used. The only exception is split spoons, which are most commonly available in carbon steel; these are acceptable for use only if they are not rusty.
- A stainless steel spatula or disposable plastic scoop should be used to remove material from the sampling device.
- Unpainted wooden stakes or pin flags
- Fiberglass measuring tape (at least 200 feet in length)
- GPS Unit (if available)

IV. Procedures and Guidelines

A. Wear protective gear, as specified in the Health and Safety Plan.

B. To locate samples, identify the correct location using the pin flags or stakes. Proceed to collect a sample from the undisturbed soil adjacent to the marker following steps C and D. If markers are not present, the following procedures will be used.

1. For samples on a grid:

a. Use measuring tape to locate each sampling point on the first grid line as prescribed in the sampling plan. As each point is located, drive a numbered stake in the ground and record its location on the site map and in the logbook.

b. Proceed to sample the points on the grid line.

c. Measure to location where next grid line is to start and stake first sample. For subsequent samples on the line take two orthogonal measurements: one to the previous grid line, and one to the previous sample on the same grid line.

d. Proceed to sample the points on the grid line as described in Section C below.

e. Repeat 1c and 1d above until all samples are collected from the area.

f. Or, a GPS unit can be used to identify each location based on map coordinated, if available.

2. For non-grid samples:

a. Use steel measuring tape to position sampling point at location described in the sampling plan by taking two measurements from fixed landmarks (e.g., corner of house and fence post).

b. Note measurements, landmarks, and sampling point on a sketch in the field notebook, and on a site location map.

c. Proceed to sample as described in Section C below.

d. Repeat 2a through 2c above until all samples are collected from the area.

e. Or, a GPS unit can be used to identify each location based on map coordinated, if available.

C. To the extent possible, differentiate between fill and natural soil. If both are encountered at a boring location, sample both as prescribed in the field sampling plan. Do not locate samples in debris, tree roots, or standing water. In residential areas, do not sample in areas where residents' activities may impact the sample (e.g., barbecue areas, beneath eaves of roofs, driveways, garbage areas). If an obstacle prevents sampling at a measured grid point, move as close as possible, but up to a distance of one half the grid spacing in any direction to locate an appropriate sample. If an appropriate location cannot be found, consult with the Field Team Leader (FTL). If the FTL concurs, the sampling point will be deleted from the program. The FTL will contact the CH2M HILL project manager (PM) immediately. The PM and Navy Technical Representative (NTR) will discuss whether the point should be deleted from the program. If it is deleted, the PM will follow-up with the NTR in writing.

D. To collect samples:

1. Use a decontaminated stainless steel scoop/trowel or disposable plastic scoopto scrape away surficial organic material (grass, leaves, etc.) adjacent to

the stake. New disposable scoops or trowels may also be used to reduce the need for equipment blanks.

2. If sampling:

   a. Surface soil: Obtain soil sample by scooping soil using the augering scoop/trowel, starting from the surface and digging down to a depth of about 6 inches, or the depth specified in the workplan.

   b. Subsurface soil: Obtain the subsurface soil sample using an auger down to the depths prescribed in the field sampling plan.

3. Take a photoionizaton detector (PID) reading of the sampled soil if organics are anticipated to be present and record the response in the field notebook. Also record lithologic description and any pertinent observations (such as discoloration) in the logbook.

4. Empty the contents of the scoop/trowel into a decontaminated stainless steel pan or dedicated sealable bag.

5. Repeat this procedure until sufficient soil is collected to meet volume requirements.

6. For TCL VOC and field GC aliquots, fill sample jars directly with the trowel/ scoop or specialized sampling equipment (i.e. Encore® or Terra Core® sampler) and cap immediately upon filling. DO NOT HOMOGENIZE.

7. For TCL pesticides/PCBs and SVOCs, TAL metals, and field XRF aliquots, homogenize cuttings in the pan using a decontaminated stainless steel utensil in accordance with SOP *Decontamination of Drilling Rigs and Equipment*.

8. Transfer sample for analysis into appropriate containers with a decontaminated utensil.

9. Backfill the hole with soil removed from the borehole. To the extent possible, replace topsoil and grass and attempt to return appearance of sampling area to its pre-sampled condition. For samples in non-residential, unmowed areas, mark the sample number on the stake and leave stake in place. In mowed areas, remove stake.

V. Attachments

None.

VI. Key Checks and Items

- Use phthalate-free latex or surgical gloves and other personal protective equipment.
- Transfer volatiles first, avoid mixing.
- Decontaminate utensils before reuse, or use dedicated, disposable utensils.

STANDARD OPERATING PROCEDURE

Water-Level Measurements

I. Purpose and Scope

The purpose of this procedure is to provide a guideline for the measurement of the depth to groundwater in piezometers and monitoring wells, even where a second phase of floating liquid (e.g., gasoline) is encountered, and on staff gages in surface-water bodies. This SOP includes guidelines for discrete measurements of static water levels and does not cover the use of continuously recording loggers (see SOP *Use of Data Loggers and Pressure Transducers)*.

II. Equipment and Materials

- Electronic water-level meter (Solinst® or equivalent) with a minimum 100-foot tape; the tape should have graduations in increments of 0.01 feet or less
- Interface probe (Solinst® Model 122 Interface Meter or equivalent)

III. Procedures and Guidelines

Verify that the unit is turned on and functioning properly. Slowly lower the probe on its cable into the piezometer or well until the probe just contacts the water surface; the unit will respond with a tone or light signal. Note the depth from a reference point indicated on the piezometer or well riser. Typically this is the top of the PVC casing. If no reference is clearly visible, measure the depth to water from the northern edge of the PVC casing. If access to the top of the PVC casing is difficult, sight across the top of the locking casing adjacent to the measuring point, recording the position of the cable when the probe is at the water surface.

Measure the distance from this point to the closest interval marker on the tape, and record the water level reading in the logbook. Water levels will be measured to the nearest 0.01-foot. Also when specified in the project plans, measure and record the depth of the piezometer or well. The depth of the piezometer or well may be measured using the water-level probe with the instrument turned off.

Free product light or dense nonaqueous phase liquid may be present in the piezometer or well. If the presence of free product is suspected, the thickness of the product should be determined using appropriate equipment (e.g., Solinst® Model 122 Interface Meter). The depth to water also is determined with this equipment and the water-level meter should not be used in the piezometer or well as long as product is present. Typically, a constant sound is emitted from the device when free product is encountered and an alternating on/off beep sound is emitted when water is encountered.

The apparent elevation of the water level in the well or piezometer is determined by measuring both the apparent depth to water and the thickness of free product. The corrected water-level elevation is calculated by the following equation:

$WL_c = Wl_a +$ (Free-product thickness x 0.80)

Where WL_c = Corrected water-level elevation

Wl_a = Apparent water-level elevation

0.80 = Typical value for the density of petroleum hydrocarbon products.

If free product is detected on the surface of the water in the piezometer or well, the value of sampling should be reconsidered because of the potential for contaminating the sampling equipment.

Staff gages may be installed in some surface-water bodies. These facilities typically are constructed by attaching a calibrated, marked staff gage to a wood or metal post, driving the post into the bottom of the surface-water body, and surveying the elevation of the top of the post to a resolution or 0.01-foot. The elevation of the water in the surface-water body then can be determined by reading off the distance the water level is from the top of the post. A shield or other protection may be needed to calm the fluctuations in water level if the gage is installed at a location exposed to wind or wave.

IV. Attachments

None.

V. Key Checks

- Before each use, verify that the battery is charged by pressing the test button on the water-level meter.
- Verify that the unit is operating correctly by testing the probe in distilled or de-ionized water. Leave the unit turned off when not in use.

STANDARD OPERATING PROCEDURE

Equipment Blank and Field Blank Preparation

I. Purpose

To prepare blanks to determine whether decontamination procedures are adequate and whether any cross-contamination is occurring during sampling due to contaminated air and dust.

II. Scope

The general protocols for preparing the blanks are outlined. The actual equipment to be rinsed will depend on the requirements of the specific sampling procedure.

III. Equipment and Materials

- Blank liquid (use ASTM Type II or lab grade water)
- Millipore™ deionized water
- Sample bottles as appropriate
- Gloves
- Preservatives as appropriate

IV. Procedures and Guidelines

A. Decontaminate all sampling equipment that has come in contact with sample according to SOP *Decontamination of Personnel and Equipment.*

B. To collect an equipment blank for volatile analysis from the surfaces of sampling equipment other than pumps, pour blank water over one piece of equipment and into two 40-ml vials until there is a positive meniscus, then seal the vials. Note the sample number and associated piece of equipment in the field notebook as well as the type and lot number of the water used.

For non-volatiles analyses, one aliquot is to be used for equipment. For example, if a pan and trowel are used, place trowel in pan and pour blank fluid in pan such that pan and trowel surfaces which contacted the sample are contacted by the blank fluid. Pour blank fluid from pan into appropriate sample bottles.

Do not let the blank fluid come in contact with any equipment that has not been decontaminated.

C. When collecting an equipment blank from a pump, run an extra gallon of deionized water through the pump while collecting the pump outflow into appropriate containers. Make sure the flow rate is low when sampling VOCs. If a Grundfos Redi-Flo2 pump with disposable tubing is used, remove the disposable tubing after sampling but before decon. When decon is complete, put a 3- to 5-foot segment of new tubing onto the pump to collect the equipment blank.

D. To collect a field blank, slowly pour ASTM Type II or lab grade water directly into sample containers.

E. Document and ship samples in accordance with the procedures for other samples.

F. Collect next field sample.

V. Attachments

None.

VI. Key Checks and Items

- Wear gloves.
- Do not use any non-decontaminated equipment to prepare blank.
- Use ASTM-Type II or lab grade water.

STANDARD OPERATING PROCEDURE

Chain-of-Custody

I Purpose

The purpose of this SOP is to provide information on chain-of-custody procedures to be used under the CLEAN Program.

II Scope

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities (except wellhead samples taken for measurement of field parameters). Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This procedure identifies the necessary custody records and describes their completion. This procedure does not take precedence over region specific or site-specific requirements for chain-of-custody.

III Definitions

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. One copy of the form must be retained in the project file.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under one's custody if:

- It is in one's actual possession.
- It is in one's view, after being in one's physical possession.
- It was in one's physical possession and then he/she locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

IV Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein. The Project Manager is responsible for ensuring that chain-of-custody procedures are implemented. The Project Manager also is responsible for determining that custody procedures have been met by the analytical laboratory.

Field Team Leader - The Field Team Leader is responsible for determining that chain-of-custody procedures are implemented up to and including release to the shipper or laboratory. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sample Personnel - It is the responsibility of the field sampling personnel to initiate chain-of-custody procedures, and maintain custody of samples until they are relinquished to another custodian, the sample shipper, or to a common carrier.

V Procedures

The term “chain-of-custody” refers to procedures which ensure that evidence presented in a court of law is valid. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom, as well as providing security for the evidence as it is moved and/or passed from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain-of-possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

V.1 Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When *in situ* measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information.

Information which shall be recorded in the field logbook, when in-situ measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s),
- Contract Task Order (CTO) Number,
- Project Sample Number,
- Sample location or sampling station number,
- Date and time of sample collection and/or measurement,

- Field observations,
- Equipment used to collect samples and measurements, and
- Calibration data for equipment used

Measurements and observations shall be recorded using waterproof ink.

V.1.1 Sample Label

Samples, other than for *in situ* measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling and Analysis Plan. Each sample container is identified by a sample label (see Attachment A). Sample labels are provided, along with sample containers, by the analytical laboratory. The information recorded on the sample label includes:

- Project - CTO Number.
- Station Location - The unique sample number identifying this sample.
- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 01/21/08).
- Time - A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type and quantity of preservation added.
- Analysis - VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- Sampled By - Printed name of the sampler.
- Remarks - Any pertinent additional information.

Using only the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing the analysis from knowing the identity of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site). The field team should always follow the sample ID system prepared by the project EIS and reviewed by the Project Manager.

V.2 Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed of.

V.2.1 Field Custody Procedures

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.

- A Chain-of-Custody Record will be prepared for each individual cooler shipped and will include ***only*** the samples contained within that particular cooler. The Chain-of-Custody Record for that cooler will then be sealed in a zip-log bag and placed in the cooler prior to sealing. This ensures that the laboratory properly attributes trip blanks with the correct cooler and allows for easier tracking should a cooler become lost during transit.

- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once downloaded to the server or developed, the electronic files or photographic prints shall be serially numbered, corresponding to the logbook descriptions; photographic prints will be stored in the project files. To identify sample locations in photographs, an easily read sign with the appropriate sample/location number should be included.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions (e.g., a logbook notation would explain that a pencil was used to fill out the sample label if the pen would not function in freezing weather.)

V.2.2 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. **A Chain-of-Custody Record Form must be completed for each cooler and should include only the samples contained within that cooler**. A Chain-of-Custody Record Form example is shown in Attachment B. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as given below:

- Enter header information (CTO number, samplers, and project name).

- Enter sample specific information (sample number, media, sample analysis required and analytical method grab or composite, number and type of sample containers, and date/time sample was collected).

- Sign, date, and enter the time under "Relinquished by" entry.

- Have the person receiving the sample sign the "Received by" entry. If shipping samples by a common carrier, print the carrier to be used in this space (i.e., Federal Express).

- If a carrier is used, enter the airbill number under "Remarks," in the bottom right corner;

- Place the original (top, signed copy) of the Chain-of-Custody Record Form in a plastic zipper-type bag or other appropriate sample-shipping package. Retain the copy with field records.

- Sign and date the custody seal, a 1-inch by 3-inch white paper label with black lettering and an adhesive backing. Attachment C is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.

- Place the seal across the shipping container opening (front and back) so that it would be broken if the container were to be opened.

- Complete other carrier-required shipping papers.

The custody record is completed using waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the shipping container (enclosed with other documentation in a plastic zipper-type bag). As long as custody forms are sealed inside the shipping container and the custody seals are intact, commercial carriers are not required to sign the custody form.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

VI Quality Assurance Records

Once samples have been packaged and shipped, the Chain-of-Custody copy and airbill receipt become part of the quality assurance record.

VII Attachments

A. Sample Label
B. Chain of Custody Form
C. Custody Seal

VIII References

USEPA. *User's Guide to the Contract Laboratory Program*. Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/P-91/002), January 1991.

STANDARD OPERATING PROCEDURE

Decontamination of Personnel and Equipment

I. Purpose

To provide general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments.

II. Scope

This is a general description of decontamination procedures.

III. Equipment and Materials

- Demonstrated analyte-free, deionized ("DI") water (specifically, ASTM Type II water or lab-grade DI water)
- Potable water; must be from a municipal water supplier, otherwise an analysis must be run for appropriate volatile and semivolatile organic compounds and inorganic chemicals (e.g., Target Compound List and Target Analyte List chemicals)
- 2.5% (W/W) Liquinox® (or Alconox®) and water solution
- Concentrated (V/V) pesticide grade methanol (DO NOT USE ACETONE)
- Large plastic pails or tubs for Liquinox® and water, scrub brushes, squirt bottles for Liquinox® solution, methanol and water, plastic bags and sheets
- DOT approved 55-gallon drum for disposal of waste
- Personal Protective Equipment as specified by the Health and Safety Plan
- Decontamination pad and steam cleaner/high pressure cleaner for large equipment

IV. Procedures and Guidelines

A. PERSONNEL DECONTAMINATION

To be performed after completion of tasks whenever potential for contamination exists, and upon leaving the exclusion zone.

1. Wash boots in Liquinox® solution, then rinse with water. If disposable latex booties are worn over boots in the work area, rinse with Liquinox® solution, remove, and discard into DOT-approved 55-gallon drum.
2. Wash outer gloves in Liquinox® solution, rinse, remove, and discard into DOT-approved 55-gallon drum.
3. Remove disposable coveralls ("Tyveks") and discard into DOT-approved 55-gallon drum.
4. Remove respirator (if worn).
5. Remove inner gloves and discard.
6. At the end of the work day, shower entire body, including hair, either at the work site or at home.
7. Sanitize respirator if worn.

B. SAMPLING EQUIPMENT DECONTAMINATION—GROUNDWATER SAMPLING PUMPS

Sampling pumps are decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Spread plastic on the ground to keep equipment from touching the ground
3. Turn off pump after sampling. Remove pump from well and remove and dispose of tubing. Place pump in decontamination tube.
4. Turn pump back on and pump 1 gallon of Liquinox® solution through the sampling pump.
5. Rinse with 1 gallon of 10% methanol solution pumped through the pump. (DO NOT USE ACETONE).
6. Rinse with 1 gallon of tap water.
7. Rinse with 1 gallon of deionized water.
8. Keep decontaminated pump in decontamination tube or remove and wrap in aluminum foil or clean plastic sheeting.
9. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.
10. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in either DOT-approved 55-gallon drums or with solid waste in garbage bags, dependent on Facility/project requirements.

C. SAMPLING EQUIPMENT DECONTAMINATION—OTHER EQUIPMENT

Reusable sampling equipment is decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Before entering the potentially contaminated zone, wrap soil contact points in aluminum foil (shiny side out).
3. Rinse and scrub with potable water.
4. Wash all equipment surfaces that contacted the potentially contaminated soil/water with Liquinox® solution.
5. Rinse with potable water.
6. Rinse with distilled or potable water and methanol solution (DO NOT USE ACETONE).
7. Air dry.
8. Rinse with deionized water.
9. Completely air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling if equipment will not be used immediately.
10. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.
11. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved 55-gallon drums or with solid waste in garbage bags, dependent on Facility/project requirements.

D. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

1. Before use, wrap soil contact points in plastic to reduce need for subsequent cleaning.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with Liquinox® solution, then a towel wet with methanol solution, and finally three times with a towel wet with distilled water. Dispose of all used paper towels in a DOT-approved 55-gallon drum or with solid waste in garbage bags, dependent on Facility/project requirements.

E. SAMPLE CONTAINER DECONTAMINATION

The outsides of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection. The procedure is:

1. Wipe container with a paper towel dampened with Liquinox® solution or immerse in the solution AFTER THE CONTAINERS HAVE BEEN SEALED. Repeat the above steps using potable water.

2. Dispose of all used paper towels in a DOT-approved 55-gallon drum or with solid waste in garbage bags, dependent on Facility/project requirements.

F. HEAVY EQUIPMENT AND TOOLS

Heavy equipment such as drilling rigs, drilling rods/tools, and the backhoe will be decontaminated upon arrival at the site and between locations as follows:

1. Set up a decontamination pad in area designated by the Facility

2. Steam clean heavy equipment until no visible signs of dirt are observed. This may require wire or stiff brushes to dislodge dirt from some areas.

V. Attachments

None.

VI. Key Checks and Items

- Clean with solutions of Liquinox®, methanol, and distilled water.
- Do not use acetone for decontamination.
- Drum all contaminated rinsate and materials.
- Decontaminate filled sample bottles before relinquishing them to anyone.

STANDARD OPERATING PROCEDURE

Decontamination of Drilling Rigs and Equipment

I. Purpose and Scope

The purpose of this guideline is to provide methods for the decontamination of drilling rigs, downhole drilling tools, and water-level measurement equipment. Personnel decontamination procedures are not addressed in this SOP; refer to the site safety plan and SOP *Decontamination of Personnel and Equipment*. Sample bottles will not be field decontaminated; instead they will be purchased with certification of laboratory sterilization.

II. Equipment and Materials

- Portable steam cleaner and related equipment
- Potable water
- Phosphate-free detergent such as Liquinox®
- Buckets
- Brushes
- Methanol, pesticide grade
- Personal Protective Equipment as specified by the Health and Safety Plan
- ASTM–Type II grade water or Lab Grade DI Water
- Aluminum foil

III. Procedures and Guidelines

A. Drilling Rigs and Monitoring Well Materials

Before the onset of drilling, after each borehole, before drilling through permanent isolation casing, and before leaving the site, heavy equipment and machinery will be decontaminated by steam cleaning at a designated area. The steam-cleaning area will be designed to contain decontamination wastes and waste waters and can be an HDPE-lined, bermed pad. A pumping system will be used to convey decontaminated water from the pad to drums.

Surface casings may be steam cleaned in the field if they are exposed to contamination at the site prior to use.

B. Downhole Drilling Tools

Downhole tools will be steam cleaned before the onset of drilling, prior to drilling through permanent isolation casing, between boreholes, and prior to leaving the site. This will include, but is not limited to, rods, split spoons or similar samplers, coring equipment, augers, and casing.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for physical characterization, the sampler shall be cleaned by scrubbing with a detergent solution followed by a potable water rinse.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for chemical analysis, the sampler shall be decontaminated following the procedures outlined in the following subsection.

C. Field Analytical Equipment

1. Water Level Indicators

   Water level indicators that consist of a probe that comes into contact with the groundwater must be decontaminated using the following steps:

   a. Rinse with tap water
   b. Rinse with de-ionized water
   c. Solvent rinse with methanol
   d. Rinse with de-ionized water

2. Probes

   Probes, for example, pH or specific ion electrodes, geophysical probes, or thermometers that would come in direct contact with the sample, will be decontaminated using the procedures specified above unless manufacturer's instructions indicate otherwise. For probes that make no direct contact, for example, OVM equipment, the probe will be wiped with clean paper-towels or cloth wetted with methanol.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- The effectiveness of field cleaning procedures may be monitored by rinsing decontaminated equipment with organic-free water and submitting the rinse water in standard sample containers for analysis.

STANDARD OPERATING PROCEDURE

Disposal of Waste Fluids and Solids

I. Purpose and Scope

This SOP describes the procedures used to dispose of hazardous fluid and solid materials generated as a result of the site operations. This SOP does not provide guidance on the details of Department of Transportation regulations pertaining to the transport of hazardous wastes; the appropriate Code of Federal Regulations (49 CFR 171 through 177) should be referenced. Also, the site investigation-derived waste management plan should be consulted for additional information and should take precedence over this SOP.

II. Equipment and Materials

A. Fluids

- DOT-approved 55-gallon steel drums or Baker® Tanks
- Tools for securing drum lids
- Funnel for transferring liquid into drum
- Labels
- Paint Pens
- Marking pen for appropriate labels
- Seals for 55-gallon steel drums

B. Solids

- DOT-approved 55-gallon steel drums or rolloffs
- Tools for securing drum lids
- Paint Pens
- Plastic sheets
- Labels
- Marking pen for appropriate labels

III. Procedures and Guidelines

A. Methodology

Clean, empty drums or rolloffs or Baker® Tanks will be brought to the site by the drilling subcontractor for soil and groundwater collection and storage. The empty drums will be located at the field staging area and moved to drilling locations as required. The drums will be filled with the drilling and well installation wastes, capped, sealed, and moved to the onsite drum storage area by the drilling subcontractor. The full drums will separate types of wastes by media. The drums will be labeled as they are filled in the field and labels indicating that the contents are pending analysis affixed.

The drum contents will be sampled to determine the disposal requirements of the drilling wastes. The drum sampling will be accomplished through the collection and submittal of composite samples, one sample per 10 drums containing the same media. Similar compositing will be performed in each rolloff to obtain a representative sample. The compositing of the sample will be accomplished by collecting a specific volume of the material in each drum into a large sample container. When samples from each of the drums being sampled in a single compositing are collected, the sample will be submitted for TCLP, ignitability, corrosivity, and reactivity analysis. The analysis will be used to determine if drilling wastes are covered by land disposal restrictions.

If rolloffs are used, compositing and sampling of soil will comply with applicable state and federal regulations.

B. Labels

Drums and other containers used for storing wastes from drilling operations will be labeled when accumulation in the container begins. Labels will include the following minimum information:

- Container number
- Container contents
- Origin (source area including individuals wells, piezometers, and soil borings)
- Date that accumulation began
- Date that accumulation ended
- Generator Contact Information
- When laboratory results are received, drum labels will be completed or revised to indicate the hazardous waste constituents in compliance with Title 40 of the Code of Federal Regulations, Part 262, Subpart C if the results indicate hazardous waste or labeled as non-hazardous if applicable.

C. Fluids

Drilling fluids generated during soil boring and groundwater discharged during development and purging of the monitoring wells will be collected in 55-gallon, closed-top drums. When a drum is filled, the bung will be secured tightly. Fluids may also be transferred to Baker® Tanks after being temporarily contained in drums to minimize the amount of drums used.

When development and purging is completed, the water will be tested for appropriate hazardous waste constituents. Compositing and sampling of fluids will comply with applicable state and federal regulations.

D. Solids

The soil cuttings from well and boring drilling will constitute a large portion of the solids to be disposed of.

The solid waste stream also will include plastic sheeting used for decontamination pads, Tyveks, disposable sampling materials, and any other disposable material used during the field operations that appears to be contaminated. These materials will be placed in designated drums.

E. Storage and Disposal

The wastes generated at the site at individual locations will be transported to the drum storage area by the drilling services subcontractor. Drums should be stored on pallets on plastic sheeting with a short berm wall (hay bales or 2 x 4 planks or equivalent) to capture small spills.

Waste solid materials that contain hazardous constituents will be disposed of at an offsite location in a manner consistent with applicable solid waste, hazardous waste, and water quality regulations. Transport and disposal will be performed by a commercial firm under subcontract.

The liquid wastes meeting acceptable levels of discharge contamination may be disposed of through the sanitary sewer system at the site. However, prior to disposal to the sanitary sewer system, approval and contract arrangements will be made with the appropriate authorities. Wastes exceeding acceptable levels for disposal through the sanitary sewer system will be disposed of through contract with a commercial transport and disposal firm.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- Check that representative samples of the containerized materials are obtained.
- Be sure that all state and federal regulations are considered when classifying waste for disposal.

STANDARD OPERATING PROCEDURE

Sampling Contents of Tanks and Drums

I. Scope and Application

This procedure provides an overview approach and guidelines for the routine sampling of drums and tanks. Its purpose is to describe standard procedures and precautions which are applied in sampling drums and tanks. Procedures for opening drums with the individual instruments are included in Attachment D.

The samples obtained may be used to obtain physical chemical or radiological data. The resulting data may be qualitative or quantitative in nature, and are appropriate for use in preliminary surveys as well as confirmatory sampling.

II. References

A. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, U.S. Environmental Protection Agency, Washington, D.C., 1987.

B. *Data Quality Objectives for Remedial Activities - Development Process*, EPA/540/G-87/003, U.S. Environmental Protection Agency, Washington, D.C., 1987.

C. Annual Book of ASTM Standards, *Standard Recommended Practices for Sampling Industrial Chemicals*, ASTM-E-300, 1986.

D. *Test Method for Evaluating Solid Waste*, SW-846, Volume II, Field Methods, Second Edition, U.S. Environmental Protection Agency, Washington, D.C., 1982.

E. U.S. Environmental Protection Agency, *Characterization of Hazardous Waste Sites – A Method Manual: Volume II, Available Sampling Methods*, USEPA Environmental Monitoring Systems Laboratory, Las Vegas, EPA-600/4-84-076, December, 1984.

F. *Environmental Surveillance Procedures*, Quality Control Program, Martin Marietta Energy Systems, ESH/Sub/87-21706/1, Oak Ridge, TN, September 1988.

III. Summary of Methods

Drums are generally sampled by means of sampling tubes such as glass sample tubes or COLIWASA samplers. In either case, the sampling tube is manually inserted into the waste material. A sample of the drum contents is withdrawn by the sampling device. Should a drum contain bottom sludge, a glass tube will be used to retrieve a sample of this as well.

Storage tank and tank trailers, because of their greater depths, require sampling devices that can be lowered from the top, filled at a particular depth, then withdrawn. Such devices are a COLIWASA, a Kemmerer depth sampler, or a Bacon Bomb. Where samples of bottom sludge are desired, a gravity corer can be utilized. This heavy tube with a tapered nose piece will penetrate the sludge as it free falls through the tank.

IV. Comments

The sampling of tanks, containers, and drums present unique problems not associated with environmental samples. Containers of this sort are generally closed except for small access ports, manways, or hatches on the larger vessels, or taps and bungs on smaller drums. The physical size, shape, construction material, and location of access limit the types of equipment and methods of collection that can be used.

When liquids are contained in sealed vessels, gas vapor pressure can build up, sludges can settle out, and density layerings (stratification) can develop. Bulging drums may be under pressure and extreme caution should be exercised. The potential exists for explosive reactions or the release of noxious gases when containers are opened. All vessels should be opened with extreme caution. Check the HSP for the level of personnel protection to be worn. A preliminary sampling of any headspace gases is warranted. As a minimum, a preliminary check with an explosimeter and an organic vapor analyzer may be of aid in selecting a sampling method.

In most cases it is impossible to observe the contents of these sealed or partially sealed vessels. Since some layering or stratification is likely in any solution left undisturbed over time, a sample must be taken that represents the entire depth of the vessel.

V. Required Equipment and Apparatus

A. **Health and safety equipment/materials**: As listed in the site safety plan.

B. **Sampling equipment**: COLIWASA, glass sample tubes, Kemmerer depth sampler, Bacon Bomb, gravity corer.

C. **Tools**: Rubber mallet, bung wrench, speed wrench with socket, etc., (all non-sparking), paint marker.

D. **Heavy equipment**: Backhoe equipped with explosion shield, drum grappler, and 3-foot copper-beryllium (non-sparking) spike with 6-inch collar (to puncture top of drums for sampling, if necessary).

E. **Sample Containers**: As specified in the field sampling plan.

VI. Procedures

A. Drums

NOTE: DO NOT open more than one drum at a time. Each drum must be handled and sampled as a separate entity to reduce vapors in the sampling area.

1. Drums will be sampled on an area-by-area basis. Drums will be sampled after they have been placed in overpack drums but before they are transferred from the excavation to the onsite storage area.
2. Record, in logbook, all pertinent information from visual inspection of drum (e.g., physical condition, leaks, bulges, and labels). Label each drum with a unique identifying number.
3. If possible, stage drums for easy access.
4. If necessary, attach ground strap to drums and grounding point.
5. Remove any standing material (water, etc.) from container top.
6. Using non-sparking tools, carefully remove the bung or lid while monitoring air quality with appropriate instruments. If necessary (and as a last resort), the non-sparking spike affixed to the backhoe can also be used to puncture the drum for sampling. See Attachment D for method of drum opening. Record air-quality monitoring results.
7. When sampling a previously sealed vessel, a check should be made for the presence of bottom sludge. This is accomplished by measuring the depth to apparent bottom, then comparing it to the known interior depth.
8. Agitation to disrupt the layers and rehomogenize the sample is physically difficult and almost always undesirable. If the vessel is greater than 3 feet in depth (say, a 55-gallon drum), the appropriate sampling method is to slowly lower the sampling device (i.e., suction line of peristaltic pump, glass tube) in known increments of length. Discrete samples can be collected from various depths, then combined or analyzed separately. If the depth of the vessel is greater than the lift capacity of the pump, an at-depth water sampler, such as the Kemmerer or Bacon Bomb type, may be required.
9. Extract a representative sample from the drum using a glass rod, COLIWASA, Bacon Bomb, Kemmerer bottle, or gravity corer (See Attachments). Ensure that the entire depth of material is penetrated. Depending on the size of the opening of the drum, three to four takes should be collected from random locations across the drum surface, to ensure a representative sample. Any observed stratification must be recorded in logbook, including number and thickness of the layers and a conceptualized sketch.

10. Record a visual description of the sample (e.g., liquid, solid, color, viscosity, and percent layers).

11. When possible, sampling equipment (like glass tubes) should be expendable and be left inside the drum for disposal with drum contents, once sampling is completed.

12. Place lid, bung, cap, etc., back in place on drum. Tighten hand tight. If necessary, the sampling port can be sealed using a cork.

13. Wipe up spilled material with lab wipes. Wipe off sample containers.

14. Mark the drum with a unique sample identification number and date using a paint marker.

15. Samples will be handled as high hazard samples. Samples will be placed in containers defined according to the analytical needs, wiped clean, and then packed in paint cans for shipping. Packaging, labeling, and preparation for shipment procedures will follow procedures as specified in the field sampling plan.

B. Underground Storage Tanks

1. A sampling team of at least two people is required for sampling—one will collect samples, the other will relay required equipment and implements.

2. Sampling team will locate a sampling port on the tank. Personnel should be wearing appropriate protective clothing at this time and carrying sampling gear.

3. Do not attempt to climb down into tank. Sampling MUST BE accomplished from the top.

4. Collect a sample from the upper, middle, and lower section of the tank contents with one of the recommended sampling devices.

5. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.

6. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging, labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

C. Tank Trailers or Above-Ground Storage Tanks

1. A sampling team of two is required. One will collect samples, the other will relay required equipment and implements.

2. Samples will be collected through the manhole (hatch) on top of the tanker or the fill port. Do not open valves at the bottom. Before opening the hatch, check for a pressure gauge or release valve. Open the release valve slowly to bring the tank to atmospheric pressure.

3. If tank pressure is too great, or venting releases large amounts of toxic gas, discontinue venting and sampling immediately. Measure vented gas with organic vapor analyzer and explosimeter.

4. If no release valve exists, slowly loosen hatch cover bolts to relieve pressure in the tank. (Again, stop if pressure is too great.)

5. Once pressure in tank has been relieved, open the hatch and withdraw sample using one of the recommended sampling devices.

6. Sample each trailer compartment.

7. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.

8. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging, labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

D. Refer to Attachment B for procedures for sampling with appropriate devices as follows:

Drum

Glass tube	—	Procedure 1
COLIWASA	—	Procedure 2

Storage Tank and Tank Trailer

COLIWASA	—	Procedure 2
Bacon Bomb	—	Procedure 3
Gravity Corer (for bottom sludge)	—	Procedure 4

VII. Contamination Control

Sampling tools, instruments, and equipment will be protected from sources of contamination prior to use and decontaminated after use as specified in SOP *Decontamination of Personnel and Equipment*. Liquids and materials from decontamination operations will be handled in accordance with the waste management plan. Sample containers will be protected from sources of contamination. Sampling personnel shall wear chemical resistant gloves when handling any samples. Gloves will be decontaminated or disposed of between samples.

VIII. Attachments

A. Collection of Liquid-Containerized Wastes Using Glass Tubes

B. Sampling Containerized Wastes Using the Composite Liquid Waste Sample (COLIWASA)

C. Sampling Containerized Wastes Using the Bacon Bomb Sampler

D. Gravity Corer for sampling Sludges in Large Containers

E. Construction of a Typical COLIWASA

F. Drum Opening Techniques and Equipment

IX. Field Checklist

_______ Sampling Instruments

_______ Tools

_______ Rubber Mallet

_______ Logbook

_______ Safety Glasses or Monogoggles

_______ Safety Shoes

_______ Ice/Cooler, as required

_______ Custody Seals, as required

_______ Chain-of-Custody Forms

_______ Drum Labels, as required

_______ Paint Marker, if drum sampling

_______ Black Indelible Pen

_______ Monitoring Instruments

_____ Labels

_____ Sampling and Analysis Plan

_____ Health and Safety Plan

_____ Decontamination Equipment

_____ Lab Wipes

_____ Lab Spatulas or Stainless Steel Spoons

_____ Chemical Preservatives, as required

_____ Appropriate Containers for Waste and Equipment

_____ Duct Tape

_____ Plastic Sheeting

Attachment A Collection of Liquid-Containerized Wastes Using Glass Tubes

Discussion

Liquid samples from opened containers (i.e., 55-gallon drums) are collected using lengths of glass tubing. The glass tubes are normally 122 centimeters long and 6 to 16 millimeters inside diameter. Larger diameter tubes may be used for more viscous fluids if sampling with the small diameter tube is not adequate. The tubing is broken and discarded in the container after the sample has been collected, eliminating difficult cleanup and disposal problems. This method should not be attempted with less than a two-person sampling team.

Uses

This method provides for a quick, relatively inexpensive means of collecting concentrated containerized wastes. The major disadvantage is from potential sample loss that is especially prevalent when sampling low-viscosity fluids. Splashing can also be a problem and proper protective clothing should always be worn.

Note: A flexible tube with an aspirator attached is an alternative method to the glass tube, and allows various levels to be sampled discretely.

Procedures for Use

1. Remove cover from sample container.
2. Insert glass tubing almost to the bottom of the container. Tubing should be of sufficient length so that at least 30 centimeters extend above the top of the container.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Cap the top of the tube with a safety-gloved thumb or a stopper.
5. Carefully remove the capped tube from the drum. If the tube has passed through more than one layer, the boundary should be apparent in the glass tube.
6. Insert the bottom, uncapped end into the sample container.
7. Partially release the thumb or stopper on the top of the tube and allow the sample to slowly flow into the sample container. If separation of phases is desired, cap off tube before the bottom phase has completely emptied. It may be advisable to have an extra container for "waste," so that the fluid on either side of the phase boundary can be directed into a separate container, allowing collection of pure phase liquids in the sample containers. The liquid remaining after the boundary fluid is removed is collected in yet a third container. NOTE: It is not necessary to put phases in separate containers if analysis of separate phases is not desired.
8. Repeat steps 2 through 6 if more volume is needed to fill the sample container.

9. Remove the tube from the sample container and replace the tube in the drum, breaking it, if necessary, in order to dispose of it in the drum.

Optional Method (if sample of bottom sludge is desired)

1. Remove the cover from the container opening.
2. Insert glass tubing slowly almost to the bottom of the container. Tubing should be of sufficient length so that at least 30 cm extends above the top of the container.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Gently push the tube towards the bottom of the drum into the sludge layer. Do not force it.
5. Cap the top of the tube with a safety-gloved thumb or stopper.
6. Carefully remove the capped tube from the drum and insert the uncapped end into the sample container.
7. Release the thumb or stopper on the top of the tube and allow the sample container to fill to approximately 90 percent of its capacity. If necessary, the sludge plug in the bottom of the tube can be dislodged with the aid of the stainless steel laboratory spatula.
8. Repeat if more volume is needed to fill sample container and recap the tube.

Note:

1. If a reaction is observed when the glass tube is inserted (violent agitation, smoke, light, etc.), the investigators should leave the area immediately.
2. If the glass tube becomes cloudy or smoky after insertion into the drum, the presence of hydrofluoric acid maybe indicated, and a comparable length of rigid plastic tubing should be used to collect the sample.
3. When a solid is encountered in a drum (either layer or bottom sludge) the optional method described above may be used to collect a core of the material, or the material may be collected with a disposable scoop attached to a length of wooden or plastic rod.

Attachment B: Sampling Containerized Wastes using the Composite Liquid Waste Sampler (COLIWASA)

Discussion

The COLIWASA is a much-cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized wastes. The sampler is commercially available or can be easily fabricated from a variety of materials, including PVC, glass, or Teflon. In its usual configuration it consists of a 152 cm by 4 cm (inside diameter) section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end. Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper. See Attachment E: Construction of a COLIWASA.

Uses

The COLIWASA is primarily used to sample containerized liquids. The PVC COLIWASA is reported to be able to sample most containerized liquid wastes except for those containing ketones, nitrobenzene, dimethylforamide, mesityloxide, and tetrahydrofuran. A glass COLIWASA is able to handle all wastes unable to be sampled with the plastic unit except strong alkali and hydrofluoric acid solutions. Due to the unknown nature of many containerized wastes, it would therefore be advisable to eliminate the use of PVC materials and use samplers composed of glass or Teflon.

The major drawback associated with using a COLIWASA is concern for decontamination and costs. The sampler is difficult, if not impossible, to decontaminate in the field, and its high cost in relation to alternative procedures (glass tubes) makes it an impractical throwaway item. It still has applications, however, especially in instances where a true representation of a multiphase waste is absolutely necessary.

Procedures for Use

1. Check to make sure the sampler is functioning properly. Adjust the locking mechanism, if present, to make sure the neoprene rubber stopper provides a tight closure.

2. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.

3. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.

4. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.

5. Slowly withdraw the sampler from the waste container with one hand while wiping the sampler tube with a laboratory wipe with the other hand. A phase boundary, if present, can be observed through the tube.

6. Carefully discharge the sample into a suitable sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.

7. Unscrew the T-handle of the sampler and disengage the locking block.

Attachment C: Sampling Containerized Wastes using the Bacon Bomb Sampler

Discussion

The Bacon Bomb is designed for the withdrawal of samples from various levels within a storage tank. It consists of a cylindrical body with an internal tapered plunger that acts as a valve to admit the sample. A line attached to the top of the plunger is used to open and close the valve. A removable cover provides a point of attachment for the sample line and has a locking mechanism to keep the plunger closed after sampling. The Bacon Bomb is usually constructed of chrome-plated brass and bronze with a rubber O-ring acting as the plunger-sealing surface. Stainless steel versions are also available. The volumemetric capacity is 8, 16, or 32 oz (237, 473, or 946 ml).

<u>Uses</u>

The Bacon Bomb is a heavy sampler suited best for viscous materials held in large storage tanks or in lagoons. If a more non-reactive sampler is needed, the stainless steel version would be used, or any of the samplers could be coated with Teflon.

<u>Procedures for Use</u>

1. Attach the sample line and the plunger line to the sampler.
2. Measure and then mark the sampling line at the desired depth.
3. Gradually lower the sampler by the sample line until the desired level is reached.
4. When the desired level is reached, pull up on the plunger line and allow the sampler to fill for a sufficient length of time before releasing the plunger line to seal off the sampler.
5. Retrieve the sampler by the sample line, being careful not to pull up on the plunger line, thereby accidentally opening the bottom valve.
6. Wipe off the exterior of the sampler body.
7. Position the sampler over the sample container and release its contents by pulling up on the plunger line.

Attachment D: Gravity Corer for Sampling Sludges in Large Containers

Discussion

A gravity corer is a metal tube with a replaceable tapered nosepiece on the bottom and a ball or other type of check valve on the top. The check valve allows water to pass through the corer on descent but prevents a washout during recovery. The tapered nosepiece facilitates cutting and reduces core disturbance during penetration. Most corers are constructed of brass or steel and many can accept plastic liners and additional weights.

Uses

Corers are capable of collecting samples of most sludges and sediments. They collect essentially undisturbed samples that represent the strata profile that may develop in sediments and sludges during variations in the deposition process. Depending on the density of the substrate and the weight of the corer, penetration to depths of 75 cm (30 in.) can be attained. Exercise care when using gravity corers in vessels or lagoons that have liners because penetration depths could exceed those of the substrate; this could result in damage to the liner material.

Procedures for Use

1. Attach a precleaned corer to the required length of sample line. Solid braided 5-mm (3/16-in.) nylon line is sufficient; however, 20-mm (3/4-in.) nylon is easier to grasp during hand hoisting. An additional weight can be attached to the outside of the corer if necessary.
2. Secure the free end of the line to a fixed support to prevent accidental loss of the corer.
3. Allow corer to free fall through the liquid to the bottom.
4. Retrieve corer with a smooth, continuous, up-lifting motion. Do not bump corer because this may result in some sample loss.
5. Remove nosepiece from corer and slide sample out of corer into stainless steel or Teflon pan (preferred).
6. Transfer sample into appropriate sample bottle with a stainless steel lab spoon or laboratory spatula.

Attachment E: Construction of a Typical COLIWASA

The sampling tube consists of a 1.52-m (5-ft) by 4.13-cm (1-5/8 in) I.D. translucent plastic pipe, usually polyvinyl chloride (PVC) or borosilicate glass plumbing tube. The closure-locking mechanism consists of a short-length, channeled aluminum bar attached to the sampler's stopper rod by an adjustable swivel. The aluminum bar serves both as a T-handle and lock for the samplers' closure system. When the sampler is in the open position, the handle is placed in the T-position and pushed down against the locking block. This manipulation pushes out the neoprene stopper and opens at the sampling tube. In the closed position, the handle is rotated until one leg of the T is squarely perpendicular against the locking block. This tightly seats the neoprene stopper against the bottom opening of he sampling tube and positively locks the sampler in the closed position. The closure tension can be adjusted by shortening or lengthening the stopper rod by screwing it in or out of the T-handle swivel. The closure system of the sampler consists of a sharply tapered neoprene stopper attached to a 0.95-cm (3/8-in) O.D. rod, usually PVC. The upper end of the stopper rod is connected to the swivel of the aluminum T-handle. The sharply tapered neoprene stopper can be fabricated according to specifications by plastic-products manufacturers at an extremely high price, or it can be made in-house by grinding down the inexpensive stopper with a shop grinder.

COLIWASA samplers are typically made out of plastic or glass. The plastic type consists of translucent plastic (usually PVC) sampling tube. The glass COLIWASA uses borosilicate glass plumbing pipe as the sampling tube and a Teflon plastic stopper rod. For purpose of multiphase sampling, clear plastic or glass is desirable in order to observe the profile of the multiphase liquid.

The sampler is assembled as follows:

a. Attach the swivel to the T-handle with the 3.18-cm (1-1/4 in) long bolt and secure with the 0.48-cm (3/16-in) National Coarse (NC) washer and lock nut.

b. Attach the PFTE stopper to one end of the stopper rod and secure with the 0.95-cm (3/8-in) washer and lock nut.

c. Install the stopper and stopper rod assembly in the sampling tube.

d. Secure the locking block sleeve on the block with glue or screw. This block can also be fashioned by shaping a solid plastic rod on a lathe to the required dimension.

e. Position the locking block on top of the sampling tube such that the sleeveless portion of the block fits inside the tube, the sleeve sits against the top end of the tube, and the upper end of the stopper rod slips though the center hole of the block.

f. Attach the upper end of the stopper rod to the swivel of the T-handle.

g. Place the sampler in the close position and adjust the tension on the stopper by screwing the T-handle in or out.

Attachment F: Drum Opening Techniques and Equipment [1]

I. Introduction

The opening of closed drums prior to sampling entails considerable risk if not done with the proper techniques, tools, and safety equipment. The potential for vapor exposure, skin exposure due to splash or spraying, or even explosion resulting from sparks produced by friction of the tools against the drum, necessitate caution when opening any closed container. Both manual drum opening and remote drum opening will be discussed in the following paragraphs. When drums are opened manually risks are greater than when opened remotely; for this reason, the remote opening of drums is advised whenever possible.

Prior to sampling, the drums should be staged to allow easy access. Also, any standing water or other material should be removed from the container top so that the representative nature of the sample is not compromised when the container is opened. There is also the possibility of encountering a water-reactive substance.

II. Manual Drum Opening

A. Bung Wrench

A common method for opening drums manually is using a universal bung wrench. These wrenches have fittings made to remove nearly all commonly encountered bungs. They are usually constructed of cast iron, brass, or a bronze-beryllium (a non-sparking alloy formulated to reduce the likelihood of sparks). The use of bung wrenches marked "NON SPARKING" is encouraged. However, the use of a "NON SPARKING" wrench does not completely eliminate the possibility of spark being produced. Such a wrench only prevents a spark caused by wrench-to-bung friction, but it cannot prevent sparking between the threads on the drum and the bung.

A simple tool to use, the fitting on the bung wrench matching the bung to be removed is inserted into the bung and the tool is turned counterclockwise to remove the bung. Since the contents of some drums may be under pressure (especially, when the ambient temperature is high), the bung should be turned very slowly. If any hissing is heard, the person opening the drum should back off and wait for the hissing to stop. Since drums under pressure can spray out liquids when opened, the wearing of appropriate eye and skin protection in addition to respiratory protection is critical.

B. Drum Deheader

One means by which a drum can be opened manually when a bung is not removable with a bung wrench is by using a drum deheader. This tool is

[1] Taken from EPA Training Course: "Sampling for Hazardous Materials," U.S. Environmental Protection Agency, Office of Emergency and Remedial Response Support Division, March 24, 1987.

constructed of forged steel with an alloy steel blade and is designed to cut the lid of a drum off or part way off by means of a scissors-like cutting action. A limitation of this device is that it can be attached only to closed head drums (i.e., DOT Specification 17E and 17F drums); drums with removable heads must be opened by other means.

Drums are opened with a drum deheader by first positioning the cutting edge just inside the top chime and then tightening the adjustment screw so that the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will enable the entire top to be rapidly cut off if so desired. If the top chime of a drum has been damaged or badly dented it may not be possible to cut the entire top off. Since there is always the possibility that a drum may be under pressure, the initial cut should be made very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to employ a remote pressure release method prior to using the deheader.

C. Hand Pick or Spike

When a drum must be opened and neither a bung wrench nor a drum deheader is suitable, then it can be opened for sampling by using a hand pick, pickaxe, or spike. These tools are usually constructed of brass or a non-sparking alloy with a sharpened point that can penetrate the drum lid or head when the tool is swung. The hand picks or pickaxes that are most commonly used are commercially available, whereas the spikes are generally uniquely fabricated 4- foot long poles with a pointed end. Often the drum lid or head must be hit with a great deal of force in order to penetrate it. Because of this, the potential for splash or spraying is greater than with other opening methods and therefore this method of drum opening is not recommended, particularly when opening drums containing liquids. Some spikes used for drum opening have been modified by the addition of a circular splash plate near the penetrating end. This plate acts as a shield and reduces the amount of splash in the direction of the person using the spike. Even with this shield, good splash gear is essential.

Since drums, some of which may be under pressure, cannot be opened slowly with these tools, “sprayers” may result and appropriate safety measures must be taken. The pick or spike should be decontaminated after each drum is opened to avoid cross contamination and/or adverse chemical reaction from incompatible materials.

III. Remote Opening

A. Backhoe Spike

The most common means used to open drums remotely for sampling is the use of a metal spike attached or welded to a backhoe bucket. In addition to being very efficient, this method can greatly reduce the likelihood of personnel exposure.

Drums should be “staged,” or placed in rows with adequate aisle space to allow ease in backhoe maneuvering. Once staged, the drums can be quickly opened by punching a hole in the drum head or lid with the spike.

The spike should be decontaminated after each drum is opened to prevent cross contamination. Even though some splash or spray may occur when this method is used, the operator of the backhoe can be protected by mounting a large shatter-resistant shield in front of the operator's cage. This, combined with the normal sampling safety gear, should be sufficient to protect the operator. Additional respiratory protection can be afforded by providing the operator with an on-board airline system. The hole in the drum can be sealed with a cork.

B. Hydraulic Devices

Recently, remotely operated hydraulic devices have been fabricated to open drums remotely. One such device is discussed here. This device uses hydraulic pressure to pierce through the wall of a drum. It consists of a manually operated pump that pressurizes oil through a length of hydraulic line. A piercing device with a metal point is attached to the end of this line and is pushed into the drum by the hydraulic pressure. The piercing device can be attached so that a hole for sampling can be made in either the side or the head/lid of the drum. Some of the metal piercers are hollow or tube-like so that they can be left in place, if desired, and serve as a permanent tap or sampling port. The piercer is designed to establish a tight seal after penetrating the container.

C. Pneumatic Devices

Pneumatically-operated devices utilizing compressed air have been designed to remove drum bungs remotely. A pneumatic bung remover consists of a compressed air supply (usually SCBA cylinders) that is controlled by a heavy-duty, 2-stage regulator. A high pressure air line of desired length delivers compressed air to a pneumatic drill that is adapted to turn a bung fitting (preferably, a bronze-beryllium alloy) selected to fit the bung to be removed. An adjustable bracketing system has been designed to position and align the pneumatic drill over the bung. This bracketing system must be attached to the drum before the drill can be operated. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This attachment and removal procedure is time-consuming and is the major drawback of this device. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

IV. Summary

The opening of closed containers is one of the most hazardous site activities. Maximum efforts would be made to ensure the safety of the sampling team. Proper protective equipment and a general wariness of the possible dangers will minimize the risk inherent to sampling operations. Employing proper drum opening techniques and equipment will also safeguard personnel. The use of remote sampling equipment whenever feasible is highly recommended.

STANDARD OPERATING PROCEDURE

Preparing Field Log Books

I. Purpose

This SOP provides general guidelines for entering field data into log books during site investigation and remediation activities.

II. Scope

This is a general description of data requirements and format for field log books. Log books are needed to properly document all field activities in support of data evaluation and possible legal activities.

III. Equipment and Materials

- Log book
- Indelible pen

IV. Procedures and Guidelines

Properly completed field log books are a requirement for much of the work we perform under the Navy CLEAN contract. Log books are legal documents and, as such, must be prepared following specific procedures and must contain required information to ensure their integrity and legitimacy. This SOP describes the basic requirements for field log book entries.

A. PROCEDURES FOR COMPLETING FIELD LOG BOOKS

1. Field notes commonly are kept in bound, hard-cover logbooks used by surveyors and produced, for example, by Peninsular Publishing Company and Sesco, Inc. Pages should be water-resistant and notes should be taken only with water-proof, non-erasable permanent ink, such as that provided in Sanford Sharpie® permanent markers.

2. On the inside cover of the log book the following information should be included:

   - Company name and address
   - Log-holders name if log book was assigned specifically to that person
   - Activity or location

- Project name
- Project manager's name
- Phone numbers of the company, supervisors, emergency response, etc.

3. All lines of all pages should be used to prevent later additions of text, which could later be questioned. Any line not used should be marked through with a line and initialed and dated. Any pages not used should be marked through with a line, the author's initials, the date, and the note "Intentionally Left Blank."

4. If errors are made in the log book, cross a single line through the error and enter the correct information. All corrections shall be initialed and dated by the personnel performing the correction. If possible, all corrections should be made by the individual who made the error.

5. Daily entries will be made chronologically.

6. Information will be recorded directly in the field log book during the work activity. Information will not be written on a separate sheet and then later transcribed into the log book.

7. Each page of the log book will have the date of the work and the note takers initials.

8. The final page of each day's notes will include the note-takers signature as well as the date.

9. Only information relevant to the subject project will be added to the log book.

10. The field notes will be copied and the copies sent to the Project Manager or designee in a timely manner (at least by the end of each week of work being performed).

B. INFORMATION TO BE INCLUDED IN FIELD LOG BOOKS

1. Entries into the log book should be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on the collector's memory. Entries must be legible and complete.

2. General project information will be recorded at the beginning of each field project. This will include the project title, the project number, and project staff.

3. Scope: Describe the general scope of work to be performed each day.

4. Weather: Record the weather conditions and any significant changes in the weather during the day.

5. Tail Gate Safety Meetings: Record time and location of meeting, who was present, topics discussed, issues/problems/concerns identified,

and corrective actions or adjustments made to address concerns/ problems, and other pertinent information.

6. Standard Health and Safety Procedures: Record level of personal protection being used (e.g., level D PPE), record air monitoring data on a regular basis and note where data were recording (e.g., reading in borehole, reading in breathing zone, etc). Also record other required health and safety procedures as specified in the project specific health and safety plan.

7. Instrument Calibration; Record calibration information for each piece of health and safety and field equipment.

8. Personnel: Record names of all personnel present during field activities and list their roles and their affiliation. Record when personnel and visitors enter and leave a project site and their level of personal protection.

9. Communications: Record communications with project manager, subcontractors, regulators, facility personnel, and others that impact performance of the project.

10. Time: Keep a running time log explaining field activities as they occur chronologically throughout the day.

11. Deviations from the Work Plan: Record any deviations from the work plan and document why these were required and any communications authorizing these deviations.

12. Heath and Safety Incidents: Record any health and safety incidents and immediately report any incidents to the Project Manager.

13. Subcontractor Information: Record name of company, record names and roles of subcontractor personnel, list type of equipment being used and general scope of work. List times of starting and stopping work and quantities of consumable equipment used if it is to be billed to the project.

14. Problems and Corrective Actions: Clearly describe any problems encountered during the field work and the corrective actions taken to address these problems.

15. Technical and Project Information: Describe the details of the work being performed. The technical information recorded will vary significantly between projects. The project work plan will describe the specific activities to be performed and may also list requirements for note taking. Discuss note-taking expectations with the Project Manager prior to beginning the field work.

16. Any conditions that might adversely affect the work or any data obtained (e.g., nearby construction that might have introduced excessive amounts of dust into the air).

17. Sampling Information; Specific information that will be relevant to most sampling jobs includes the following:

    - Description of the general sampling area – site name, buildings and streets in the area, etc.
    - Station/Location identifier
    - Description of the sample location – estimate location in comparison to two fixed points – draw a diagram in the field log book indicating sample location relative to these fixed points – include distances in feet.
    - Sample matrix and type
    - Sample date and time
    - Sample identifier
    - Draw a box around the sample ID so that it stands out in the field notes
    - Information on how the sample was collected – distinguish between "grab," "composite," and "discrete" samples
    - Number and type of sample containers collected
    - Record of any field measurements taken (i.e. pH, turbidity, dissolved oxygen, and temperature, and conductivity)
    - Parameters to be analyzed for, if appropriate
    - Descriptions of soil samples and drilling cuttings can be entered in depth sequence, along with PID readings and other observations. Include any unusual appearances of the samples.

C. SUGGESTED FORMAT FOR RECORDING FIELD DATA

1. Use the left side border to record times and the remainder of the page to record information (see attached example).
2. Use tables to record sampling information and field data from multiple samples.
3. Sketch sampling locations and other pertinent information.
4. Sketch well construction diagrams.

V. Attachments

Example field notes.

STANDARD OPERATING PROCEDURE

Packaging and Shipping Procedures

I. Purpose

The purpose of this SOP is to delineate protocols for the packing and shipping of samples to the laboratory for analysis.

II. Scope

This SOP is applicable for all samples collected and prepared for analysis at an offsite laboratory. Packaging and shipping must be performed daily, when required, at the end of a sampling activity. Packaging should be done carefully to ensure the integrity of the samples and the physical conditions of sample containers. Shipping should be performed based on the requirements of the samples obtained (temperature, life time, etc.).

III. Equipment and Materials

- Coolers
- Labels
- Tape
- Garbage bags
- Zip-loc® bags
- Ice
- Absorbent packing material (bubble wrap, vermiculite, etc.)
- Sample containers
- Chain of custody
- Custody seal

IV. Procedures and Guidelines

A. Prepare coolers for shipment.

- Tape drains shut.
- Place mailing label with laboratory address on top of coolers.
- Fill bottom of coolers with packing material.

B. Arrange decontaminated sample containers in groups by sample number. Consolidate VOC samples into one cooler to minimize the need for trip blanks.

C. Affix appropriate adhesive sample labels to each container. Protect with clear label protection tape.

D. Seal each sample bottle within a separate Zip-loc® plastic bag or bubble wrap, if available. Tape the bag around bottle. Sample label should be visible through the bag.

E. Line cooler with garbage bag.

F. Arrange sample bottles in garbage bag so that they do not touch.

G. If ice is required to preserve the samples, cubes should be repackaged in Zip-loc® bags and placed on and around the containers.

H. Fill remaining spaces with packing material.

I. Complete and sign chain-of-custody form (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier.

J. Separate copies of forms. Seal proper copies (traffic reports, packing lists) along with a return address label within a large Zip-loc® bag and tape to inside lid of cooler.

K. Close lid and latch.

L. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.

M. Tape cooler shut on both ends, making several complete revolutions with strapping tape. Do not cover custody seals.

N. Relinquish to Federal Express or to a courier arranged with the laboratory.

O. Contact the analytical laboratory the day following shipment to verify that the samples arrived.

Standard Operating Procedure

Locating and Clearing Underground Utilities

I. Purpose

The purpose of this SOP is to provide general guidelines and specific procedures that must be followed on Navy CLEAN projects for locating underground utilities and clearing dig locations in order to maximize our ability to avoid hitting underground utilities and to minimize liabilities to CH2M HILL and its subcontractors and health and safety risks to our project staff.

This SOP shall be used by Activity Managers and Project Managers to, in-turn, develop Activity-specific and project-specific utility location procedures. The activity and project-specific procedures will become part of work plans and project instructions and will be used to prepare scopes of work (SOWs) for the procurement of utility location subcontractors to meet the needs of individual projects.

This SOP also identifies the types of utility locating services that are available from subcontractors and the various tools that are used to locate utilities, and discusses when each type of service and tool may or may not be applicable.

II. Scope

Depending on the Navy/Marine Activity we typically find ourselves in one of two scenarios:

Scenario 1

The Activity provides utility locating (or dig clearance) services through the public works department or similar organization, or has a contract with an outside utility clearance service. Some of these services are provided in the form of dig permits which are required before you can dig or drill. In other cases no official permit is required and the process is somewhat vague.

Scenario 2

The Activity does not get involved in any utility locating processes aside from possibly providing the most recent utility maps, and relies on CH2M HILL to clear the dig locations.

Table 1 provides an up to date summary of which scenarios apply to the various primary Activities served under the Navy CLEAN program.

Scenario 1 is preferred because under this scenario the Navy tends to assume the responsibility if the location is improperly cleared, a utility is struck, and property damage results. However, our experience has been that the clearance services provided by the Navy do not meet the standards that we consider to be adequate, in that they often simply rely on available base maps to mark utilities and do not verify locations using field geophysics. And if they do use locating tools, they do not provide adequate documentation or marking to confirm that a location has been cleared. So while the Navy's process may protect us from liability for property damage, it does not adequately protect our staff and subcontractors from health risks nor does it compensate us for down time, should a utility be hit.

Therefore, regardless of what services the Navy provides, in most cases we still need to supplement this effort with clearance services from our own third party utility location subcontractor following the procedures and guideline outlined in Section IV of this SOP. The cost implications of providing this service will range from $500 to several $1,000 depending on the size of the project.

The scope of services that we ask our subcontractors to provide can involve utility marking/mapping or the clearing of individual dig locations. In the former we ask our subs to mark all utilities within a "site" and often ask them to prepare a map based on their work. In the later, we ask them to clear (identify if there are any utilities within) a certain radius of a proposed dig/drill location.

The appropriate requested scope of services for a project will depend on the project. Clearing individual boreholes is often less expensive and allows the sub to concentrate their efforts on a limited area. However if the scope of the investigation is fluid (all borehole locations are not predetermined) it may be best to mark and map an entire site or keep the subcontractor on call.

Clearance of individual dig locations should be done to a minimum 20 foot radius around the location.

An example SOW for a utility subcontractor procurement is provided in Attachment A.

III. Services and Equipment

This section provides a general description of the services available to help us locate subsurface utilities and describes the types of equipment that these services may (or may not) use to perform their work. It identifies the capabilities of each type of equipment to help the PM specify what they should require from our utility location subs.

Services

The services that are available to us for identifying and marking underground utilities are:

- The local public/private utility-run service such as Miss Utility
- Utility location subcontractors (hired by us)

Attachment B provides a detailed description of each type of organization. It also provides contact numbers and web sites for the various Miss-Utility-type organizations in the areas where we do work for the Navy and contacts and services provided by several subcontractors that we have used or spoken to in the past.

Equipment

Attachment C provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the PM determine if the equipment being used by a subcontractor is adequate.

It is important to make the potential subcontractors aware of the possible types of utilities (and utility materials) that are at the site, and to have them explain in their bid what types of equipment they will use to locate utilities /clear dig locations, and what the limitations of these equipment are.

A list of in-house experts that can be used to help you evaluate bids or answer questions you may have is provided in Appendix C.

IV. Procedures and Guidelines

This section presents specific procedures to be followed for the utility location work to be conducted by CH2M HILL and our subcontractors. In addition, a PM will have to follow the procedures required by the Activity to obtain their approvals, clearances and dig permits where necessary. These "dig permit" requirements vary by Activity and must be added to the project-specific SOP, or project instructions. It is preferable that the Activity perform their clearance processes before we follow up with our clearance work.

Activity Notification and Dig Permit Procedures

Identify Activity-specific permit and/or procedural requirements for excavation and drilling activities. Contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.

Activity Specific: To be provided by Activity or Project Manager

CH2M HILL Utility Clearance Procedures

Do not begin subsurface construction activities (e.g., trenching, excavation, drilling, etc.) until a check for underground utilities and similar obstructions has been conducted by CH2M HILL as a follow-up to the services provided by the Navy. The use of as-built drawings and utility company searches must be supplemented with a geophysical or other survey by a qualified, independent survey contractor (subcontracted to CH2M HILL) to identify additional and undiscovered buried utilities.

Examples of the type of geophysical technologies include (these are further described in Attachment C):

- **Ground Penetrating Radar (GPR),** which can detect pipes, including gas pipes, tanks, conduits, cables etc, both metallic and non-metallic at depths up to 30 feet depending on equipment. Sensitivity for both minimum object size and maximum depth detectable depends on equipment selected, soil conditions, etc.
- **Radio Frequency (RF),** involves inducing an RF signal in the pipe or cable and using a receiver to trace it. Some electric and telephone lines emit RF naturally and can be

detected without an induced signal. This method requires knowing where the conductive utility can be accessed to induce RF field if necessary.

- **Dual RF**, a modified version of RF detection using multiple frequencies to enhance sensitivity but with similar limitations to RF
- **Ferromagnetic Detectors**, are metal detectors that will detect ferrous and non-ferrous utilities. Sensitivity is limited, e.g. a 100 mm iron disk to a depth of about one meter or a 25 mm steel paper clip to a depth of about 20 cm.
- **Electronic markers,** are emerging technologies that impart a unique electronic signature to materials such as polyethylene pipe to facilitate location and tracing after installation. Promising for future installations but not of help for most existing utilities already in place.

The following procedures shall be used to identify and mark underground utilities during subsurface construction activities on the project:

- Contact utility companies or the state/regional utility protection service (such as Miss Utility) at least two (2) working days prior to intrusive activities to advise of the proposed work, and ask them to establish the location of the utility underground installations prior to the start of actual excavation: this is a law. These services will only mark the location of public-utility-owned lines and not Navy-owned utilities. In many cases there will not be any public-utility-owned lines on the Activity. There may also be Base-access issues to overcome.
- Procure and schedule the independent survey.
- The survey contractor shall determine the most appropriate geophysical technique or combinations of techniques to identify the buried utilities on the project site, based on the survey contractor's experience and expertise, types of utilities anticipated to be present and specific site conditions. ***The types of utilities must be provided to the bidding subcontractors in the SOW and procedures to be used must be specified by the bidder in their bid. It is extremely helpful to provide the sub with utility maps, with the caveat that all utilities are not necessarily depicted.***
- The survey subcontractor shall employ the same geophysical techniques used to identify the buried utilities, to survey the proposed path of subsurface investigation/construction work to confirm no buried utilities are present.
- Obtain utility clearances for subsurface work on both public and private property.
- Clearances provided by both the "Miss Utility" service and the CH2M HILL-subcontracted service are to be in writing, signed by the party conducting the clearance. The Miss Utility service will have standard notification forms/letters which typically simply state that they have been to the site and have done their work. The CH2M HILL subcontractor shall be required to fill out the form provided in Attachment D (this can be modified for a particular project) indicating that each dig/drill location has been addressed. ***This documentation requirement (with a copy of the form) needs to be provided in the subcontractor SOW.***

- Marking shall be done using the color coding presented in Attachment E. The type of material used for marking must be approved by the Activity prior to marking. Some base commanders have particular issues with persistent spray paint on their sidewalks and streets. ***Any particular marking requirements need to be provided in the subcontractor SOW.***
- Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, the Project Manager must notify the utility company or utility protection service to inform them that the markings have been destroyed.
- Perform a field check prior to drilling/digging (preferably while the utility location sub is still at the site) to see if field utility markings coincide with locations on utility maps. Look for fire hydrants, valves, manholes, light poles, lighted signs, etc to see if they coincide with utilities identified by the subcontractor.
- Underground utility locations must be physically verified (or dig locations must be physically cleared) by hand digging using wood or fiberglass-handled tools, air knifing, or by some other acceptable means approved by CH2M HILL, when the dig location (e.g. mechanical drilling, excavating) is expected to be within 5 feet of a marked underground system. Hand clearance shall be done to a depth of four feet unless a utility cross-section is available that indicates the utility is at a greater depth. In that event, the hand clearance shall proceed until the documented depth of the utility is reached.
- Conduct a site briefing for employees at the start of the intrusive work regarding the hazards associated with working near the utilities and the means by which the operation will maintain a safe working environment. Detail the method used to isolate the utility and the hazards presented by breaching the isolation.
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon during drilling or change in color, texture or density during excavation that could indicate the ground has been previously disturbed).

IV. Attachments

A- Example SOW for Utility Location Subcontractor Procurement
B - Services Available for Identifying and Marking Underground Utilities
C – Equipment Used for Identifying Underground Utilities
D – Utility Clearance Documentation Form
E – Utility Marking Color Codes

Attachment A – Example SOW for Subcontracting Underground Utilities Locating Services

CTO-XXX

Scope of Work

Subsurface Utility Locating

Site XX

Navy Activity

City, State

A licensed and insured utility locator will be subcontracted to identify and mark out subsurface utilities for an environmental investigation/remediation project at Site XX of <<insert name of base, city, and state>>. The subcontractor will need to be available beginning at <<insert time>> on <<insert date>>. It is estimated that the work can be completed within XX days.

Proposed Scope of Work

The subcontractor will identify and mark all subsurface utilities (CHOOSE 1) that lie within a radius of 20 feet of each of XX sampling locations at Site XX shown on the attached Figure 1; (OR) that lie within the bounds of Site XX as delineated on the attached Figure 1. (If multiple sites are to be cleared, provide maps of each site with sample locations or clearance boundaries clearly delineated and a scale provided.)

Utilities will be identified using all reasonably available as-built drawings, electronic locating devices, and any other means necessary to maintain the safety of drilling and sampling personnel and the protection of the base infrastructure. The location of utilities identified from as-built drawings or other maps must be verified in the field prior to marking.

Base utility drawings for the Site(s) (CHOOSE 1) can be found at <<insert specific department and address or phone number on the base>> and should be reviewed by the subcontractor and referenced as part of the utility locating. (OR), will be provided to the subcontractor by CH2M HILL upon the award of the subcontract. (OR), are not available. Utility drawings shall not be considered definitive and must be field verified.

Field verification will include detection using nonintrusive subsurface detection equipment (magnetometers, GPR, etc) as well as opening manhole covers to verify pipe directions. As part of the bid, the Subcontractor shall provide a list of the various subsurface investigation tools they propose to have available and use at the site and what the limitations are of each tool.

A CH2M HILL representative shall be present to coordinate utility clearance activities and identify points and features to be cleared.

Field Marking and Documentation

All utilities located within **(CHOOSE 1)** ***a 20-ft radius of the XX proposed soil boring locations*** **(OR)** ***within the boundary of the site(s)*** as identified on the attached figure(s) will be marked using **paint** ***(some Bases such as the WNY may have restrictions on the use of permanent paint)*** and/or pin flags color coded to indicate electricity, gas, water, steam, telephone, TV cable, fiber optic, sewer, etc. The color coding shall match the industry standard as described on the attached form. In addition, the ***Buried Utility Location Tracking Form*** (attached) will be completed by the Subcontractor based upon what is identified in the field during the utility locating and submitted back to CH2M HILL (field staff or project manager) within <u>24 hours</u> of completing the utility locating activities.

(OPTIONAL) ***The subcontractor shall also provide a map (or hand sketch) of the identified utilities to the Engineer within XX days of field demobilization. The map shall include coordinates or ties from fixed surface features to each identified subsurface utility.***

Bid Sheet/Payment Units

The subcontractor will bid on a time and materials basis for time spent on site and researching utility maps. Mobilization (including daily travel to the site) should be bid as a lump sum, as well as the preparation of the AHA and any required mapping. The per diem line item should be used if the field crew will require overnight accommodations at the project site.

Health and Safety Requirements

The utility locating subcontractor is to provide and assume responsibility for an adequate corporate Health and Safety Plan for onsite personnel. Standard personal safety equipment including: hard hat, safety glasses, steel-toed boots, gloves are recommended for all project activities. Specific health and safety requirements will be established by the Subcontractor for each project. The health and safety requirements will be subject to the review of CH2M HILL.

The subcontractor shall also prepare and provide to the Engineer, at least 48 hours prior to mobilization, an acceptable Activity Hazard Analysis (AHA) using the attached AHA form or similar.

It is also required that all subcontractor personnel who will be on site attend the daily 15-minute health and safety tailgate meeting at the start of each day in the field.

Subcontractor personnel showing indications of being under the influence of alcohol or illegal drugs will be sent off the job site and their employers will be notified. Subcontractor personnel under the influence of prescription or over-the-counter medication that may impair their ability to operate equipment will not be permitted to do so. It is expected that the subcontractor will assign them other work and provide a capable replacement (if necessary) to operate the equipment to continue work.

Security

The work will be performed on US Navy property. CH2M HILL will identify the Subcontractor personnel who will perform the work to the appropriate Navy facility point-of-contact, and will identify the Navy point-of-contact to the Subcontractor crew. The Subcontractor bears final responsibility for coordinating access of his personnel onto Navy property to perform required work. This responsibility includes arranging logistics and providing to CH2M HILL, in advance or at time of entry as specified, any required identification information for the Subcontractor personnel. Specifically, the following information should be submitted with the bid package for all personnel that will perform the work in question (this information is required to obtain a base pass):

- Name
- Birth Place
- Birth Date
- Social Security Number
- Drivers License State and Number
- Citizenship

Please be advised that no weapons, alcohol, or drugs will be permitted on the Navy facility at any time. If any such items are found, they will be confiscated, and the Subcontractor will be dismissed.

Quality Assurance

The Subcontractor will be licensed and insured to operate in the State of <<state>> and will comply with all applicable federal, state, county and local laws and regulations. The subcontractor will maintain, calibrate, and operate all electronic locating instruments in accordance with the manufacturer's recommendations. Additionally, the Subcontractor shall make all reasonable efforts to review as-built engineering drawings maintained by Base personnel, and shall notify the CH2M HILL Project Manager in writing (email is acceptable) whenever such documentation was not available or could not be reviewed.

Subcontractor Standby Time

At certain periods during the utility locating activities, the Subcontractor's personnel may be asked to stop work and standby when work may normally occur. During such times, the Subcontractor will cease activities until directed by the CH2M HILL representative to resume operations. Subcontractor standby time also will include potential delays caused by the CH2M HILL representative not arriving at the site by the agreed-upon meeting time for start of the work day. Standby will be paid to the

Subcontractor at the hourly rate specified in the Subcontractor's Bid Form attached to these specifications.

Cumulative Subcontractor standby will be accrued in increments no shorter than 15 minutes (i.e., an individual standby episode of less than 15 minutes is not chargeable).

During periods for which standby time is paid, the surveying equipment will not be demobilized and the team will remain at the site. At the conclusion of each day, the daily logs for the Subcontractor and CH2M HILL representative will indicate the amount of standby time incurred by the Subcontractor, if any. Payment will be made only for standby time recorded on CH2M HILL's daily logs.

Down Time

Should equipment furnished by the Subcontractor malfunction, preventing the effective and efficient prosecution of the work, or inclement weather conditions prevent safe and effective work from occurring, down time will be indicated in the Subcontractor's and CH2M Hill representative's daily logs. No payment will be made for down time.

Schedule

It is anticipated that the subsurface utility locating activities will occur on <<insert date>>. It is estimated that the above scope will be completed within XXX days.

Attachment B - Services Available for Identifying and Marking Underground Utilities

The services that are available to us for identifying and marking underground utilities are:

- The Activity's PWC (or similar organization)
- The local public/private utility -run service such as Miss Utility
- Utility location subcontractors (hired by CH2M HILL)

Each are discussed below.

Navy Public Works Department

A Public Works Department (PWD) is usually present at each Activity. The PWD is responsible for maintaining the public works at the base including management of utilities. In many cases, the PWD has a written permit process in place to identify and mark-out the locations of Navy-owned utilities [Note: The PWD is usually NOT responsible for the locations/mark-outs of non-Navy owned, public utilities (e.g., Washington Gas, Virginia Power, municipal water and sewer, etc.). Therefore, it is likely that we will have to contact other organizations besides the PWD in order to identify non-Navy owned, public utilities].

At some Activities, there may not be a PWD, the PWD may not have a written permit process in place, or the PWD may not take responsibility for utility locating and mark-outs. In these cases, the PWD should still be contacted since it is likely that they will have the best understanding of the utility locations at the Activity (i.e., engineering drawings, institutional knowledge, etc.). Subsequently, the PWD should be brought into a cooperative arrangement (if possible) with the other services employed in utility locating and mark-out in order to have the most comprehensive assessment performed.

At all Activities we should have a contact (name and phone number), and preferably an established relationship, with PWD, either directly or through the NAVFAC Atlantic, Midlant, or Washington NTR or Activity Environmental Office that we can work with and contact in the event of problems.

Miss Utility or "One Call" Services for Public Utility Mark-outs

Miss Utility or "One Call" service centers are information exchange centers for excavators, contractors and property owners planning any kind of excavation or digging. The "One Call" center notifies participating public utilities of the upcoming excavation work so they can locate and mark their underground utilities in advance to prevent possible damage to underground utility lines, injury, property damage and service outages. In some instances, such with southeastern Virginia bases, the Navy has entered into agreement with Ms. Utilities and is part of the response process for Miss

Utilities. Generally, a minimum of 48 hours is required for the public utility mark-outs to be performed. The "One Call" services are free to the public. Note that the "One Call" centers only coordinate with participating public utilities. There may be some public utilities that do NOT participate in the "One Call" center which may need to be contacted separately. For example, in Washington, DC, the Miss Utility "One Call" center does not locate and mark public sewer and water lines. Therefore, the municipal water and sewer authority must be contacted separately to have the sewer and water lines marked out. The AM should contact the appropriate one-call center to determine their scope of services.

A national listing of the "One Call" service centers for each state is presented on the web at http://www.underspace.com/refs/ocdir.htm. For the Mid-Atlantic region, the following "One Call" service centers are available.

Name	Phone	Website	Comments
Miss Utility of DELMARVA	800-257-7777	www.missutility.net	Public utility mark-outs in Delaware, Maryland, Washington, DC, and Northern Virginia
Miss Utility of Southern Virginia (One Call)	800-552-7001	not available	Public utility mark-outs in Southern Virginia
Miss Utility of Virginia	800-257-7777 800-552-7007	www.missutilityofvirginia.com	General information on public utility mark-outs in Virginia, with links to Miss Utility of DELMARVA and Miss Utility of Southern Virginia (One Call)
Miss Utility of West Virginia, Inc	800-245-4848	none	Call to determine what utilities they work with in West Virginia
North Carolina One Call Center	800-632-4949	www.ncocc.org/ncocc/default.htm	Public Utility Markouts in North Carolina

Private Subcontractors

1. Utility-locating support is required at some level for most all CH2M HILL field projects in "clearing" proposed subsurface boring locations on the project site. Utility location and sample clearance can include a comprehensive effort of GIS map interpretation, professional land surveying, field locating, and geophysical surveying. Since we can usually provide our own GIS-related services for projects and our professional land surveying services are normally procured separately, utility-locating subcontractors will normally only be required for some level of geophysical surveying support in the field. This level of geophysical surveying support can range widely from a simple electromagnetic (EM) survey over a known utility line, to a blind geophysical effort, including a ground-penetrating radar (GPR) survey and/or a comprehensive EM survey to delineate and characterize all unknown subsurface anomalies.

   The level of service required from the subcontractor will vary depending on the nature of the site. At sites where utility locations are well defined on the maps and recent construction is limited, CH2M HILL may be confident with a limited effort from a traditional utility-locating subcontractor providing a simple EM survey. At sites where utility locations are not well defined, where recent constructions may have altered utility locations, or the nature of the site makes utility location difficult, CH2M HILL will require the services of a comprehensive geophysical surveying subcontractor, with a wide range of GPR and EM services available for use on an "as-needed" basis. Typical costs for geophysical surveying subcontractors will range from approximately $200 per day for a simple EM effort (usually one crew member and one instrument) to approximately $1,500 per day for a comprehensive geophysical surveying effort (usually a two-person crew and multiple instruments). Comprehensive geophysical surveying efforts may also include field data interpretation (and subsequent report preparation) and non-destructive excavation to field-verify utility depths and locations.

The following table provides a list of recommended geophysical surveying support subcontractors that can be used for utility-locating services:

Company Name and Address	**Contact Name and Phone Number**	**Equipment[1]**					**Other Services[2]**		
		1	**2**	**3**	**4**	**5**	**A**	**B**	**C**
US Radar, Inc.* PO Box 319 Matawan, NJ 07747	Ron LaBarca 732-566-2035			4					
Utilities Search, Inc.*	Jim Davis 703-369-5758	4				4	4	4	4
So Deep, Inc.* 8397 Euclid Avenue Manassas Park, VA 20111	703-361-6005	4					4	4	4
Accurate Locating, Inc. 1327 Ashton Rd., Suite 101 Hanover, MD 21076	Ken Shipley 410-850-0280	4	4						
NAEVA Geophysics, Inc. P.O. Box 7325 Charlottesville, VA 22906	Alan Mazurowski 434-978-3187	4	4	4	4	4	4	4	4
Earth Resources Technology. Inc. 8106 Stayton Rd. Jessup, MD 20794	Peter Li 240-554-0161	4	4	4	4	4	4	4	
Geophex, Ltd 605 Mercury Street Raleigh, NC 27603	I. J. Won 919-839-8515	4	4	4	4	4	4	4	4

Notes:

*Companies denoted with an asterisk have demonstrated reluctance to assume responsibility for damage to underground utilities or an inability to accommodate the insurance requirements that CH2M HILL requests for this type of work at many Navy sites.

[1]Equipment types are:

1. Simple electromagnetic instruments, usually hand-held
2. Other, more innovative, electromagnetic instruments, including larger instruments for more area coverage
3. Ground-penetrating radar systems of all kinds
4. Audio-frequency detectors of all kinds
5. Radio-frequency detectors of all kinds

[2]Other services include:

A. Data interpretation and/or report preparation to provide a permanent record of the geophysical survey results and a professional interpretation of the findings, including expected accuracy and precision.
B. Non-destructive excavation to field-verify the depths, locations, and types of subsurface utilities.
C. Concrete/asphalt coring and pavement/surface restoration.

Attachment C – Equipment Used for Identifying Underground Utilities

This attachment provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the AM and PM determine if the equipment being proposed by a subcontractor or Navy is adequate. A list of in-house experts that can be used to answer questions you may have is provided below.

CH2M HILL In-house Utility Location Experts

Tamir Klaff/WDC

Home Office Phone – 703-669-9611

Electromagnetic Induction (EMI) Methods

EMI instruments, in general, induce an electromagnetic field into the ground (the primary field) and then record the response (the secondary field), if any. Lateral changes in subsurface conductivity, such as caused by the presence of buried metal or by significant soil variations, cause changes in the secondary field recorded by the instrument and thus enable detection and mapping of the subsurface features. It should be noted that EMI only works for electrically conductive materials--plastic or PVC pipes are generally not detected with EMI. Water and gas lines are commonly plastic, although most new lines include a copper "locator" strip on the top of the PVC to allow for detection with EMI.

EMI technology encompasses a wide range of instruments, each with inherent strengths and weaknesses for particular applications. One major division of EMI is between "time-domain" and "frequency-domain" instruments that differ in the aspect of the secondary field they detect. Another difference in EMI instruments is the operating frequency they use to transmit the primary field. Audio- and radio-frequencies are often used for utility detection, although other frequencies are also used. Consideration of the type of utility expected, surface features that could interfere with detection, and the "congestion" of utilities in an area, should be made when choosing a particular EMI instrument for a particular site.

One common EMI tool used for utility location is a handheld unit that can be used to quickly scan an area for utilities and allows for marking locations in "real time". This method is most commonly used by "dig-safe" contractors marking out known utilities prior to excavation. It should be noted that this method works best when a signal (the primary field) can be placed directly onto the line (i.e., by clamping or otherwise connecting to the end of the line visible at the surface, or for larger utilities such as sewers, by running a transmitter through the utility). These types of tools also have a limited capability to scan an area for unknown utilities. Usually this requires having enough area to separate a hand held transmitter at least a hundred feet from the receiver. Whether hunting for unknown, or confirming known, utilities, this method will only detect continuous lengths of metallic conductors.

In addition to the handheld EMI units, larger, more powerful EMI tools are available that provide more comprehensive detection and mapping of subsurface features. Generally, data with these methods are collected on a regular grid in the investigation area, and are then analyzed to locate linear anomalies that can be interpreted as utilities. These methods will usually detect *all* subsurface metal (above a minimum size), including pieces of abandoned utilities. In addition, in some situations, backfill can be detected against native soils giving information on trenching and possible utility location. Drawbacks to these methods are that the secondary signals from utilities are often swamped (i.e., undetectable) close to buildings and other cultural features, and that the subsurface at heavily built-up sites may be too complicated to confidently interpret completely.

Hand-held metal detectors (treasure-finders) are usually based on EMI technology. They can be used to locate shallow buried metal associated with utilities (e.g., junctions, manholes, metallic locators). Advantages of these tools is the ease of use and real-time marking of anomalies. Drawbacks include limited depths of investigations and no data storage capacity.

Ground Penetrating Radar (GPR)

GPR systems transmit radio and microwave frequency (e.g., 80 megaHertz to 1,000 megaHertz) waves into the ground and then record reflections of those waves coming back to the surface. Reflections of the radar waves typically occur at lithologic changes, subsurface discontinuities, and subsurface structures. Plastic and PVC pipes can sometimes be detected in GPR data, especially if they are shallow, large, and full of a contrasting material such as air in a wet soil, or water in a dry soil. GPR data are usually collected in regular patterns over an area and then analyzed for linear anomalies that can be interpreted as utilities. GPR is usually very accurate in x-y location of utilities, and can be calibrated at a site to give very accurate depth information as well. A significant drawback to GPR is that depth of investigation is highly dependant on background soil conductivity, and it will not work on all sites. It is not uncommon to get only 1-2 feet of penetration with the signal in damp, clayey environments. Another drawback to GPR is that sites containing significant fill material (e.g., concrete rubble, scrap metal, garbage) will result in complicated anomalies that are difficult or impossible to interpret.

Magnetic Field Methods

Magnetic field methods rely on detecting changes to the earth's magnetic field caused by ferrous metal objects. This method is usually more sensitive to magnetic metal (i.e., deeper detection) than EMI methods. A drawback to this method is it is more susceptible to being swamped by surface features such as fences and cars. In addition, procedures must usually be implemented that account for natural variations in the earth's background field as it changes throughout the day. One common use of the method is to measure and analyze the gradient of the magnetic field, which eliminates most of the drawbacks to the method. It should be noted this method only detects ferrous metal, primarily iron and steel for utility location applications. Some utility detector combine magnetic and EMI methods into a single hand-held unit.

Optical Methods

Down the hole cameras may be useful in visually reviewing a pipe for empty conduits and/or vaults.

Attachment D – Utility Clearance Documentation Form

Attachment E – Utility Marking Color Codes

The following is the standard color code used by industry to mark various types of utilities and other features at a construction site.

White – Proposed excavations and borings

Pink – Temporary survey markings

Red – Electrical power lines, cables, conduits and lighting cables

Yellow – Gas, oil, steam, petroleum or gaseous materials

Orange – Communication, alarm or signal lines, cables, or conduits

Blue – Potable water

Purple – Reclaimed water, irrigation and slurry lines

Green – Sewer and storm drain lines

Seep Groundwater Sample Collection

I. Purpose

To provide a general guideline for the collection of groundwater samples from seeps, which have either limited flow or are manifested simply by damp areas on the surface of the ground.

II. Scope

The SOP covers sampling seeps with drive points, similar to the equipment used in direct-push groundwater sampling. The assumption is that, even if there is a small amount of flow at the surface, a representative sample of the groundwater discharging at the seep must be taken from below the ground surface with a drive point rather than from the water at the surface. This avoids chemical changes to the groundwater, such as volatilization of organic compounds that may occur when the groundwater comes in contact with the atmosphere.

III. Equipment and Materials

- Stainless steel or PVC drive points and extra drive rods (if needed)
- Slide hammer or sledge hammer
- Peristaltic pump with dedicated polyethylene sampling tubing or small bailer
- Pre-cleaned sample containers
- Personal Protective Equipment as specified by the Health and Safety Plan.

IV. Procedures and Guidelines

1. Decontaminate the drive point and any other non-dedicated downhole equipment (e.g., extra drive rods) in accordance with the *Decontamination of Personnel and Equipment* SOP.

2. Drive the slotted interval of the drive point to the desired sampling depth using the drive hammer or sledge hammer. The desired depth is that at which there is sufficient groundwater in the drive point to obtain a sample. It should be recognized that the recharge to the small-diameter (1 to 1.25 inch ID) drive point may be slow.

3. In cases where the drive point must be pumped, insert the polyethylene sampling tubing into the drive point. Alternatively, a small-diameter bailer may be used.

4. In cases where the drive point is emplaced in a near-horizontal orientation, such as it may have when it is driven into a seepage area in the bank of a stream, be prepared for groundwater to flow from the drive point under the force of gravity. In this situation, the screen interval of the drive point must be fully embedded in the ground for groundwater to flow from the top of the drive point.

5. Fill all sample containers, beginning with the containers for VOC analysis.

6. Remove polyethylene sampling tubing, if used, from the drive point.

7. Decontaminate all non-dedicated downhole equipment in accordance with the *Decontamination of Personnel and Equipment* SOP.

8. Abandon drive point hole (as necessary) per project specifications.

V. Key Checks and Items

1. Verify that the drive points and any extra drive rods are clean.

2. When the drive point is emplaced in a near-horizontal orientation, be sure that the screen interval is completely embedded in the ground so that groundwater will flow through the embedded screen instead of through the exposed upper screen interval.

STANDARD OPERATING PROCEDURE

Pore Water Sampling

I. Purpose and Scope

This procedure presents general guidelines for the collection of pore water samples using passive diffusion sampling procedures. The supplier of the passive diffusion samplers and passive diffusion sampler hardware should be consulted for procedures specific to the type of sampler and hardware assembly being used.

II. Equipment and Materials

- Latex or nitrile gloves
- Passive diffusion sampler diffusive membranes
- Certified, laboratory-grade, analyte-free, deionized water (for filling passive diffusion samplers if they are not pre-filled by the supplier)
- Protective canister screens (mesh, PVC, etc.)
- Resealable plastic bags (for storing dedicated passive diffusion hardware)
- Sample containers
- Liquinox
- Paper towels
- Shipping supplies (labels, coolers, and ice)

III. Procedures and Guidelines

A. Setup and Deployment of the Passive Diffusion Samplers

This section will discuss the setup and deployment of the passive diffusion samplers. It is preferred that the passive diffusion samplers be filled in the laboratory or other supplier. However, passive diffusion samplers may be filled in the field. The following discussion assumes that the passive diffusion samplers will be filled with certified, laboratory-grade deionized water in the field. Disregard Step 2 below if samplers are filled by the supplier.

Field personnel shall wear latex or nitrile gloves while setting up and handling the passive diffusion sampler. Do not expose passive diffusion samplers to areas where there are exhaust fumes or other fumes.

1. Prior to field mobilization, determine the depth(s) for installing the passive diffusion sampler. Initial passive diffusion sampling events may require that passive diffusion samplers be installed at multiple depths to determine the vertical variability of concentrations.

2. Fill the passive diffusion sampler with certified, laboratory-grade deionized water. Remove excess bubbles from the sampler and then ensure that it is securely closed.

3. Slide the filled passive diffusion sampler into a protective covering (mesh sleeve, etc.) to protect the sampler from abrasions.

4. Place passive diffusion sampler in designated sampling location.

B. Passive Diffusion Sampler Equilibration and Sample Recovery

For VOC sampling, the passive diffusion sampler should be left in the sampling location for a period of at least two weeks (14 days) prior to collection of the pore water sample.

Field personnel shall wear latex or nitrile gloves when collecting water samples. Gloves shall be replaced after the sampler has been removed from the sampling location but prior to sample collection. Passive diffusion sample recovery should be conducted as follows:

1. Examine the exterior of the sampler for tears in the membrane material. Make a detailed observation in the field notes of any residues or discoloration on the exterior of the sampler. Water from samplers in which the membrane has been damaged cannot be submitted for analysis.

2. Decontaminate the sampler with a liquinox/deionized water wash and deionized water rinse.

3. To minimize cross contamination, remove any excess liquid from the exterior of the sampler by wiping off the sampler with a paper towel.

4. To transfer the water from the sampler to sample containers, open the sampler and slowly tilt the sampler over the sample containers, trying to avoid spilling any of the water.

5. Any unused water in the passive diffusion sampler should be transferred to a 55-gallon drum and managed per the Investigation Derived Waste Management Plan.

6. Dispose the passive diffusion sampler membrane and gloves in accordance with the Investigation Derived Waste Management Plan.

IV. Attachments

None.

V. Key Checks

- Carefully handle the passive diffusion samplers during setup and retrieval as to avoid damage to the sampler membranes or cross contamination.

- Do not expose passive diffusion samplers to areas where there are exhaust fumes or other fumes.

- Determine depths for passive diffusion sampler installation prior to field mobilization. Passive diffusion samplers may require installation at multiple depths during initial deployment.
- When possible, use pre-filled passive diffusion samplers.
- Do not use water from passive diffusion samplers for laboratory analysis if the passive diffusion sampler membrane is damaged.
- For VOC analysis, passive diffusion samplers will require at least two weeks between deployment and sample recovery.

Appendix B
Department of Defense Laboratory Accreditation Letter

LABORATORY
ACCREDITATION
BUREAU

Certificate of Accreditation

ISO/IEC 17025:2005 ***Certificate Number L2226***

Empirical Laboratories, LLC

621 Mainstream Drive, Suite 270
Nashville, TN 37228

has met the requirements set forth in L-A-B's policies and procedures, all requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the U.S. Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP).*

The accredited lab has demonstrated technical competence to a defined "Scope of Accreditation" and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Accreditation Granted through: November 30, 2012

R. Douglas Leonard, Jr., Managing Director
Laboratory Accreditation Bureau
Presented the 30th of November 2009

*See the laboratory's Scope of Accreditation for details of the DoD ELAP requirements
Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).

LABORATORY ACCREDITATION BUREAU

Scope of Accreditation
For
Empirical Laboratories, LLC

621 Mainstream Drive, Suite 270
Nashville, TN 37228
Marcia K. McGinnity
1-877-345-1113

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.1) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to Empirical Laboratories, LLC to perform the following tests:

Accreditation granted through: **November 30, 2012**

Testing - Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,1-Trichloroethane (1,1,1-TCA)
GC/MS	EPA 8260B	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)
GC/MS	EPA 8260B	1,1,2-Trichloroethane
GC/MS	EPA 8260B	1,1-Dichloroethane (1,1-DCA)
GC/MS	EPA 8260B	1,1-Dichloroethene (1,1-DCE)
GC/MS	EPA 8260B	1,1-Dichloropropene
GC/MS	EPA 8260B	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B	1,2,3-Trichloropropane
GC/MS	EPA 8260B	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 8260B	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260B	1,2-Dichlorobenzene
GC/MS	EPA 8260B	1,2-Dichloroethane (EDC)
GC/MS	EPA 8260B	1,2-Dichloropropane
GC/MS	EPA 8260B	1,3,5-Trimethylbenzene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B	1,3-Dichlorobenzene
GC/MS	EPA 8260B	1,3-Dichloropropane
GC/MS	EPA 8260B	1,4-Dichlorobenzene
GC/MS	EPA 8260B	1-Chlorohexane
GC/MS	EPA 8260B	2,2-Dichloropropane
GC/MS	EPA 8260B	2-Butanone (Methyl ethyl ketone; MEK)
GC/MS	EPA 8260B	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B	2-Chlorotoluene
GC/MS	EPA 8260B	2-Hexanone (Methyl butyl ketone; MBK)
GC/MS	EPA 8260B	4-Chlorotoluene
GC/MS	EPA 8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)
GC/MS	EPA 8260B	Acetone
GC/MS	EPA 8260B	Acrolein
GC/MS	EPA 8260B	Acrylonitrile
GC/MS	EPA 8260B	Benzene
GC/MS	EPA 8260B	Bromobenzene
GC/MS	EPA 8260B	Bromochloromethane
GC/MS	EPA 8260B	Bromodichloromethane
GC/MS	EPA 8260B	Bromoform
GC/MS	EPA 8260B	Bromomethane
GC/MS	EPA 8260B	Carbon Disulfide
GC/MS	EPA 8260B	Carbon Tetrachloride
GC/MS	EPA 8260B	Chlorobenzene
GC/MS	EPA 8260B	Chloroethane
GC/MS	EPA 8260B	Chloroform
GC/MS	EPA 8260B	Chloromethane
GC/MS	EPA 8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)
GC/MS	EPA 8260B	cis-1,3-Dichloropropene
GC/MS	EPA 8260B	Cyclohexane
GC/MS	EPA 8260B	Dibromochloromethane
GC/MS	EPA 8260B	Dibromomethane
GC/MS	EPA 8260B	Dichlorodifluoromethane (CFC-12)
GC/MS	EPA 8260B	Di-isopropyl ether

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8260B	ETBE
GC/MS	EPA 8260B	Ethyl methacrylate
GC/MS	EPA 8260B	Ethylbenzene
GC/MS	EPA 8260B	Hexachlorobutadiene
GC/MS	EPA 8260B	Iodomethane
GC/MS	EPA 8260B	Isopropylbenzene (Cumene)
GC/MS	EPA 8260B	Methyl Acetate
GC/MS	EPA 8260B	Methyl methacrylate
GC/MS	EPA 8260B	Methyl Tertiary Butyl Ether (MTBE)
GC/MS	EPA 8260B	Methylcyclohexane
GC/MS	EPA 8260B	Methylene Chloride, or Dichloromethane
GC/MS	EPA 8260B	Naphthalene
GC/MS	EPA 8260B	n-Butylbenzene
GC/MS	EPA 8260B	n-Propylbenzene
GC/MS	EPA 8260B	p-Isopropyltoluene
GC/MS	EPA 8260B	sec-Butylbenzene
GC/MS	EPA 8260B	Styrene
GC/MS	EPA 8260B	t-Butyl alcohol
GC/MS	EPA 8260B	tert-Amyl methyl ether
GC/MS	EPA 8260B	tert-Butylbenzene
GC/MS	EPA 8260B	Tetrachloroethene (PCE; PERC)
GC/MS	EPA 8260B	Tetrahydrofuran
GC/MS	EPA 8260B	Toluene
GC/MS	EPA 8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)
GC/MS	EPA 8260B	trans-1,3-Dichloropropene
GC/MS	EPA 8260B	Trichloroethene (TCE)
GC/MS	EPA 8260B	Trichlorofluoromethane (CFC-11)
GC/MS	EPA 8260B	Vinyl acetate
GC/MS	EPA 8260B	Vinyl Chloride (VC)
GC/MS	EPA 8260B	Xylenes (Total)
GC/MS	EPA 8270C/D	1,1'-Biphenyl
GC/MS	EPA 8270C/D	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D	1,2,4-Trichlorobenzene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	1,2-Dichlorobenzene
GC/MS	EPA 8270C/D	1,2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1,3-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dioxane
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D	2,4,6-Trichlorophenol (TCP)
GC/MS	EPA 8270C/D	2,4-Dichlorophenol (DCP)
GC/MS	EPA 8270C/D	2,4-Dimethylphenol
GC/MS	EPA 8270C/D	2,4-Dinitrophenol
GC/MS	EPA 8270C/D	2,4-Dinitrotoluene (DNT)
GC/MS	EPA 8270C/D	2,6-Dichlorophenol
GC/MS	EPA 8270C/D	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol (o-Cresol)
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 8270C/D	2-Nitrophenol (ONP)
GC/MS	EPA 8270C/D	3,3'-Dichlorobenzidine (DCB)
GC/MS	EPA 8270C/D	3-Methylphenol
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4,6-Dinitro-2-methylphenol (DNOC)
GC/MS	EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 8270C/D	4-Chlorophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Methylphenol (p-Cresol)
GC/MS	EPA 8270C/D	4-Nitroaniline (PNA)
GC/MS	EPA 8270C/D	4-Nitrophenol (PNP)
GC/MS	EPA 8270C/D	7,12-Dimethylbenz(a)anthracene

LABORATORY ACCREDITATION BUREAU

Certificate # L2226

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Acenaphthene
GC/MS	EPA 8270C/D	Acenaphthylene
GC/MS	EPA 8270C/D	Acetaphenone
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 8270C/D	Benzidine
GC/MS	EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D	Benzoic Acid
GC/MS	EPA 8270C/D	Benzyl alcohol
GC/MS	EPA 8270C/D	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270C/D	bis(2-Chloroethyl)ether (BCEE)
GC/MS	EPA 8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)
GC/MS	EPA 8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)
GC/MS	EPA 8270C/D	Butyl benzyl phthalate (BBP)
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole
GC/MS	EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Dibenz(a,h)anthracene
GC/MS	EPA 8270C/D	Dibenzofuran (DBF)
GC/MS	EPA 8270C/D	Diethyl phthalate (DEP)
GC/MS	EPA 8270C/D	Dimethyl phthalate (DMP)
GC/MS	EPA 8270C/D	Di-n-butyl phthalate (DBP)
GC/MS	EPA 8270C/D	Di-n-octyl phthalate (DNOP)
GC/MS	EPA 8270C/D	Fluoranthene
GC/MS	EPA 8270C/D	Fluorene
GC/MS	EPA 8270C/D	Hexachlorobenzene (HCB)

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Hexachlorobutadiene (HCBD)
GC/MS	EPA 8270C/D	Hexachlorocyclopentadiene (HCCPD)
GC/MS	EPA 8270C/D	Hexachloroethane (HCE)
GC/MS	EPA 8270C/D	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Naphthalene
GC/MS	EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	N-Nitrosodimethylamine
GC/MS	EPA 8270C/D	N-Nitroso-di-n-propylamine (NDPA)
GC/MS	EPA 8270C/D	N-nitrosodiphenylamine (NDPHA)
GC/MS	EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 8270C/D	Phenanthrene
GC/MS	EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/ECD	EPA 8081A/B	4,4'-DDD
GC/ECD	EPA 8081A/B	4,4'-DDE
GC/ECD	EPA 8081A/B	4,4'-DDT
GC/ECD	EPA 8081A/B	Aldrin
GC/ECD	EPA 8081A/B	alpha-BHC (alpha-HCH)
GC/ECD	EPA 8081A/B	alpha-Chlordane
GC/ECD	EPA 8081A/B	beta-BHC (beta-HCH)
GC/ECD	EPA 8081A/B	delta-BHC (delta-HCH)
GC/ECD	EPA 8081A/B	Dieldrin
GC/ECD	EPA 8081A/B	Endosulfan I
GC/ECD	EPA 8081A/B	Endosulfan II
GC/ECD	EPA 8081A/B	Endosulfan sulfate
GC/ECD	EPA 8081A/B	Endrin
GC/ECD	EPA 8081A/B	Endrin aldehyde
GC/ECD	EPA 8081A/B	Endrin ketone
GC/ECD	EPA 8081A/B	gamma-BHC (Lindane; gamma-HCH)
GC/ECD	EPA 8081A/B	gamma-Chlordane
GC/ECD	EPA 8081A/B	Heptachlor

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081A/B	Heptachlor epoxide
GC/ECD	EPA 8081A/B	Methoxychlor
GC/ECD	EPA 8081A/B	Chlordane
GC/ECD	EPA 8081A/B	Toxaphene
GC/ECD	EPA 8082 /A	Aroclor-1016
GC/ECD	EPA 8082 /A	Aroclor-1221
GC/ECD	EPA 8082 /A	Aroclor-1232
GC/ECD	EPA 8082 /A	Aroclor-1242
GC/ECD	EPA 8082 /A	Aroclor-1248
GC/ECD	EPA 8082 /A	Aroclor-1254
GC/ECD	EPA 8082 /A	Aroclor-1260
GC/ECD	EPA 8082 /A	Aroclor-1262
GC/ECD	EPA 8082 /A	Aroclor-1268
GC/ECD	EPA 8151A	2,4,5-T
GC/ECD	EPA 8151A	2,4,5-TP (Silvex)
GC/ECD	EPA 8151A	2,4-D
GC/ECD	EPA 8151A	2,4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichlorprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP (Mecoprop)
HPLC/UV	EPA 8330A/B	1,3,5-Trinitrobenzene
HPLC/UV	EPA 8330A/B	1,3-Dinitrobenzene
HPLC/UV	EPA 8330A/B	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	EPA 8330A/B	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	EPA 8330A/B	2,4-Dinitrotoluene (DNT)
HPLC/UV	EPA 8330A/B	2,6-Dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Amino-4,6-dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Nitrotoluene (ONT)
HPLC/UV	EPA 8330A/B	3,5-Dinitroaniline
HPLC/UV	EPA 8330A/B	3-Nitrotoluene

Non-Potable Water		
Technology	**Method**	**Analyte**
HPLC/UV	EPA 8330A/B	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330A/B	4-Nitrotoluene (PNT)
HPLC/UV	EPA 8330A/B	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	EPA 8330A/B	Nitrobenzene
HPLC/UV	EPA 8330A/B	Nitroglycerin
HPLC/UV	EPA 8330A/B	Nitroguanidine
HPLC/UV	EPA 8330A/B	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	EPA 8330A/B	3,5-Dinitroaniline
HPLC/UV	EPA 8330A/B	PETN
GC/FID	FLPRO	Petroleum Range Organics
GC/FID	EPA 8015B	TPH DRO
GC/FID	EPA 8015B	TPH GRO
GC/FID	RSK-175	Methane
GC/FID	RSK-175	Ethane
GC/FID	RSK-175	Ethene
GC/ECD	EPA 8011	1,2-Dibromoethane (EDB)
GC/ECD	EPA 8011	1,2-Dibromo-3-chloropropane (DBCP)
HPLC/MS	EPA 6850	Perchlorate
ICP	EPA 6010B/C	Aluminum
ICP	EPA 6010B/C	Antimony
ICP	EPA 6010B/C	Arsenic
ICP	EPA 6010B/C	Barium
ICP	EPA 6010B/C	Beryllium
ICP	EPA 6010B/C	Boron
ICP	EPA 6010B/C	Cadmium
ICP	EPA 6010B/C	Calcium
ICP	EPA 6010B/C	Chromium, total
ICP	EPA 6010B/C	Cobalt
ICP	EPA 6010B/C	Copper
ICP	EPA 6010B/C	Iron
ICP	EPA 6010B/C	Lead
ICP	EPA 6010B/C	Magnesium
ICP	EPA 6010B/C	Manganese

Non-Potable Water		
Technology	**Method**	**Analyte**
CVAA	EPA 6010B/C	Mercury
ICP	EPA 6010B/C	Molybdenum
ICP	EPA 6010B/C	Nickel
ICP	EPA 6010B/C	Potassium
ICP	EPA 6010B/C	Selenium
ICP	EPA 6010B/C	Silver
ICP	EPA 6010B/C	Sodium
ICP	EPA 6010B/C	Strontium
ICP	EPA 6010B/C	Thallium
ICP	EPA 6010B/C	Tin
ICP	EPA 6010B/C	Titanium
ICP	EPA 6010B/C	Vanadium
ICP	EPA 6010B/C	Zinc
IC	EPA 300.0	Chloride
IC	EPA 300.0	Fluoride
IC	EPA 300.0	Nitrate
IC	EPA 300.0	Nitrite
IC	EPA 300.0	Sulfate
IC	EPA 9056A	Chloride
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Nitrate
IC	EPA 9056A	Nitrite
IC	EPA 9056A	Sulfate
Titration	SM 2320B 20th/21st edition	Alkalinity
Colorimetric	SM 4500 B, G, 20th/21st edition	Ammonia
UV/Vis	EPA 7196A	Hexavalent Chromium
Colorimetric	EPA 353.2	Nitrocellulose
Colorimetric	EPA 353.2	Nitrate/Nitrite
Titration	Chap.7, Sect. 7.3.4 Mod.	Reactive Sulfide
Titration	SM 4500 S-2CF, 20th/21st edition	Sulfide
UV/Vis	SM 4500 P B5, E, 20th/21st edition	Total Phosphorus (as P)

LABORATORY ACCREDITATION BUREAU

Certificate # L2226

Non-Potable Water		
Technology	**Method**	**Analyte**
UV/Vis	SM 4500 PE, 20th/21st edition	Ortho-Phosphate (as P)
TOC	9060A/SM5310C, 20th/21st edition	Total Organic Carbon
Gravimetric	SM 2540C, 20th/21st edition	TDS
Colorimetric	EPA 9012A/B	Cyanide
Physical	EPA 1010A	Ignitability
Physical	EPA 9095B	Paint Filter
Probe	EPA 9040B/C	pH
Preparation	**Method**	**Type**
Preparation	EPA 1311	TCLP
Preparation	EPA 3005A	Metals digestion
Preparation	EPA 3010A	Metals digestion
Preparation	EPA 3510C	Organics Liquid Extraction
Preparation	EPA 5030A/B	Purge and Trap Water

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B	1,1,1-Trichloroethane (1,1,1-TCA)
GC/MS	EPA 8260B	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)
GC/MS	EPA 8260B	1,1,2-Trichloroethane
GC/MS	EPA 8260B	1,1-Dichloroethane (1,1-DCA)
GC/MS	EPA 8260B	1,1-Dichloroethene (1,1-DCE)
GC/MS	EPA 8260B	1,1-Dichloropropene
GC/MS	EPA 8260B	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B	1,2,3-Trichloropropane
GC/MS	EPA 8260B	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 8260B	1,2-Dibromoethane (EDB)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B	1,2-Dichlorobenzene
GC/MS	EPA 8260B	1,2-Dichloroethane (EDC)
GC/MS	EPA 8260B	1,2-Dichloropropane
GC/MS	EPA 8260B	1,3,5-Trimethylbenzene
GC/MS	EPA 8260B	1,3-Dichlorobenzene
GC/MS	EPA 8260B	1,3-Dichloropropane
GC/MS	EPA 8260B	1,4-Dichlorobenzene
GC/MS	EPA 8260B	2,2-Dichloropropane
GC/MS	EPA 8260B	2-Butanone (Methyl ethyl ketone; MEK)
GC/MS	EPA 8260B	2-Chlorotoluene
GC/MS	EPA 8260B	2-Hexanone (Methyl butyl ketone; MBK)
GC/MS	EPA 8260B	4-Chlorotoluene
GC/MS	EPA 8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)
GC/MS	EPA 8260B	Acetone
GC/MS	EPA 8260B	Acrolein
GC/MS	EPA 8260B	Acrylonitrile
GC/MS	EPA 8260B	Benzene
GC/MS	EPA 8260B	Bromobenzene
GC/MS	EPA 8260B	Bromochloromethane
GC/MS	EPA 8260B	Bromodichloromethane
GC/MS	EPA 8260B	Bromoform
GC/MS	EPA 8260B	Bromomethane
GC/MS	EPA 8260B	Carbon Disulfide
GC/MS	EPA 8260B	Carbon Tetrachloride
GC/MS	EPA 8260B	Chlorobenzene
GC/MS	EPA 8260B	Chloroethane
GC/MS	EPA 8260B	Chloroform
GC/MS	EPA 8260B	Chloromethane
GC/MS	EPA 8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)
GC/MS	EPA 8260B	cis-1,3-Dichloropropene
GC/MS	EPA 8260B	Cyclohexane
GC/MS	EPA 8260B	Dibromochloromethane

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Certificate # L2226

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B	Dibromomethane
GC/MS	EPA 8260B	Dichlorodifluoromethane (CFC-12)
GC/MS	EPA 8260B	Ethyl methacrylate
GC/MS	EPA 8260B	Ethylbenzene
GC/MS	EPA 8260B	Hexachlorobutadiene
GC/MS	EPA 8260B	Iodomethane
GC/MS	EPA 8260B	Isopropylbenzene (Cumene)
GC/MS	EPA 8260B	Methyl Acetate
GC/MS	EPA 8260B	Methyl methacrylate
GC/MS	EPA 8260B	Methyl Tertiary Butyl Ether (MTBE)
GC/MS	EPA 8260B	Methylcyclohexane
GC/MS	EPA 8260B	Methylene Chloride, or Dichloromethane
GC/MS	EPA 8260B	Naphthalene
GC/MS	EPA 8260B	n-Butylbenzene
GC/MS	EPA 8260B	n-Propylbenzene
GC/MS	EPA 8260B	p-Isopropyltoluene
GC/MS	EPA 8260B	sec-Butylbenzene
GC/MS	EPA 8260B	Styrene
GC/MS	EPA 8260B	tert-Butylbenzene
GC/MS	EPA 8260B	Tetrachloroethene (PCE; PERC)
GC/MS	EPA 8260B	Toluene
GC/MS	EPA 8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)
GC/MS	EPA 8260B	trans-1,3-Dichloropropene
GC/MS	EPA 8260B	Trichloroethene (TCE)
GC/MS	EPA 8260B	Trichlorofluoromethane (CFC-11)
GC/MS	EPA 8260B	Vinyl acetate
GC/MS	EPA 8260B	Vinyl Chloride (VC)
GC/MS	EPA 8260B	Xylenes (Total)
GC/MS	EPA 8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)
GC/MS	EPA 8270C/D	1,1'-Biphenyl
GC/MS	EPA 8270C/D	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D	1,2,4-Trichlorobenzene

LABORATORY ACCREDITATION BUREAU

Certificate # L2226

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	1,2-Dichlorobenzene
GC/MS	EPA 8270C/D	1,2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1,3-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dioxane
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D	2,4,6-Trichlorophenol (TCP)
GC/MS	EPA 8270C/D	2,4-Dichlorophenol (DCP)
GC/MS	EPA 8270C/D	2,4-Dimethylphenol
GC/MS	EPA 8270C/D	2,4-Dinitrophenol
GC/MS	EPA 8270C/D	2,4-Dinitrotoluene (DNT)
GC/MS	EPA 8270C/D	2,6-Dichlorophenol
GC/MS	EPA 8270C/D	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol (o-Cresol)
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 8270C/D	2-Nitrophenol (ONP)
GC/MS	EPA 8270C/D	3,3'-Dichlorobenzidine (DCB)
GC/MS	EPA 8270C/D	3-Methylphenol
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4,6-Dinitro-2-methylphenol (DNOC)
GC/MS	EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 8270C/D	4-Chlorophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Methylphenol (p-Cresol)
GC/MS	EPA 8270C/D	4-Nitroaniline (PNA)
GC/MS	EPA 8270C/D	4-Nitrophenol (PNP)

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Certificate # L2226

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Acenaphthene
GC/MS	EPA 8270C/D	Acenaphthylene
GC/MS	EPA 8270C/D	Acetaphenone
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 8270C/D	Benzidine
GC/MS	EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D	Benzoic Acid
GC/MS	EPA 8270C/D	Benzyl alcohol
GC/MS	EPA 8270C/D	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270C/D	bis(2-Chloroethyl)ether (BCEE)
GC/MS	EPA 8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)
GC/MS	EPA 8270C/D	Butyl benzyl phthalate (BBP)
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole
GC/MS	EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Dibenz(a,h)anthracene
GC/MS	EPA 8270C/D	Dibenzofuran (DBF)
GC/MS	EPA 8270C/D	Diethyl phthalate (DEP)
GC/MS	EPA 8270C/D	Dimethyl phthalate (DMP)
GC/MS	EPA 8270C/D	Di-n-butyl phthalate (DBP)
GC/MS	EPA 8270C/D	Di-n-octyl phthalate (DNOP)
GC/MS	EPA 8270C/D	Fluoranthene
GC/MS	EPA 8270C/D	Fluorene
GC/MS	EPA 8270C/D	Hexachlorobenzene (HCB)

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Certificate # L2226

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Hexachlorobutadiene (HCBD)
GC/MS	EPA 8270C/D	Hexachlorocyclopentadiene (HCCPD)
GC/MS	EPA 8270C/D	Hexachloroethane (HCE)
GC/MS	EPA 8270C/D	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Naphthalene
GC/MS	EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	N-Nitrosodimethylamine
GC/MS	EPA 8270C/D	N-Nitroso-di-n-propylamine (NDPA)
GC/MS	EPA 8270C/D	N-nitrosodiphenylamine (NDPHA)
GC/MS	EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 8270C/D	Phenanthrene
GC/MS	EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/ECD	EPA 8081A/B	4,4'-DDD
GC/ECD	EPA 8081A/B	4,4'-DDE
GC/ECD	EPA 8081A/B	4,4'-DDT
GC/ECD	EPA 8081A/B	Aldrin
GC/ECD	EPA 8081A/B	alpha-BHC (alpha-HCH)
GC/ECD	EPA 8081A/B	alpha-Chlordane
GC/ECD	EPA 8081A/B	beta-BHC (beta-HCH)
GC/ECD	EPA 8081A/B	delta-BHC (delta-HCH)
GC/ECD	EPA 8081A/B	Chlordane
GC/ECD	EPA 8081A/B	Dieldrin
GC/ECD	EPA 8081A/B	Endosulfan I
GC/ECD	EPA 8081A/B	Endosulfan II
GC/ECD	EPA 8081A/B	Endosulfan sulfate
GC/ECD	EPA 8081A/B	Endrin
GC/ECD	EPA 8081A/B	Endrin aldehyde
GC/ECD	EPA 8081A/B	Endrin ketone
GC/ECD	EPA 8081A/B	gamma-BHC (Lindane; gamma-HCH)

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Certificate # L2226

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081A/B	gamma-Chlordane
GC/ECD	EPA 8081A/B	Heptachlor
GC/ECD	EPA 8081A/B	Heptachlor epoxide
GC/ECD	EPA 8081A/B	Methoxychlor
GC/ECD	EPA 8081A/B	Toxaphene
GC/ECD	EPA 8082 /A	Aroclor-1016
GC/ECD	EPA 8082 /A	Aroclor-1221
GC/ECD	EPA 8082 /A	Aroclor-1232
GC/ECD	EPA 8082 /A	Aroclor-1242
GC/ECD	EPA 8082 /A	Aroclor-1248
GC/ECD	EPA 8082 /A	Aroclor-1254
GC/ECD	EPA 8082 /A	Aroclor-1260
GC/ECD	EPA 8082 /A	Aroclor-1262
GC/ECD	EPA 8082 /A	Aroclor-1268
GC/ECD	EPA 8151A	2,4,5-T
GC/ECD	EPA 8151A	2,4,5-TP (Silvex)
GC/ECD	EPA 8151A	2,4-D
GC/ECD	EPA 8151A	2,4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichlorprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP (Mecoprop)
HPLC/UV	EPA 8330A	1,3,5-Trinitrobenzene
HPLC/UV	EPA 8330A	1,3-Dinitrobenzene
HPLC/UV	EPA 8330A	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	EPA 8330A	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	EPA 8330A	2,4-Dinitrotoluene (DNT)
HPLC/UV	EPA 8330A	2,6-Dinitrotoluene
HPLC/UV	EPA 8330A	2-Amino-4,6-dinitrotoluene
HPLC/UV	EPA 8330A	2-Nitrotoluene (ONT)

LABORATORY ACCREDITATION BUREAU

Certificate # L2226

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
HPLC/UV	EPA 8330A	3-Nitrotoluene
HPLC/UV	EPA 8330A	3,5-Dinitroaniline
HPLC/UV	EPA 8330A	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330A	4-Nitrotoluene (PNT)
HPLC/UV	EPA 8330A	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	EPA 8330A	Nitroglycerin
HPLC/UV	EPA 8330A	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	EPA 8330A	Nitrobenzene
HPLC/UV	EPA 8330A	Nitroguanidine
HPLC/UV	EPA 8330A	PETN
HPLC/UV	EPA 8330B	1,3,5-Trinitrobenzene
HPLC/UV	EPA 8330B	1,3-Dinitrobenzene
HPLC/UV	EPA 8330B	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	EPA 8330B	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	EPA 8330B	2,4-Dinitrotoluene (DNT)
HPLC/UV	EPA 8330B	2,6-Dinitrotoluene
HPLC/UV	EPA 8330B	2-Amino-4,6-dinitrotoluene
HPLC/UV	EPA 8330B	2-Nitrotoluene (ONT)
HPLC/UV	EPA 8330B	3-Nitrotoluene
HPLC/UV	EPA 8330B	3,5-Dinitroaniline
HPLC/UV	EPA 8330B	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330B	4-Nitrotoluene (PNT)
HPLC/UV	EPA 8330B	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	EPA 8330B	Nitroglycerin
HPLC/UV	EPA 8330B	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	EPA 8330B	Nitrobenzene
HPLC/UV	EPA 8330B	Nitroguanidine
HPLC/UV	EPA 8330B	PETN
GC/FID	FLPRO	Petroleum Range Organics
GC/FID	EPA 8015B	TPH DRO
GC/FID	EPA 8015B	TPH GRO
HPLC/MS	EPA 6850	Perchlorate

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Certificate # L2226

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP	EPA 6010B/C	Aluminum
ICP	EPA 6010B/C	Antimony
ICP	EPA 6010B/C	Arsenic
ICP	EPA 6010B/C	Barium
ICP	EPA 6010B/C	Beryllium
ICP	EPA 6010B/C	Boron
ICP	EPA 6010B/C	Cadmium
ICP	EPA 6010B/C	Calcium
ICP	EPA 6010B/C	Chromium, total
ICP	EPA 6010B/C	Cobalt
ICP	EPA 6010B/C	Copper
ICP	EPA 6010B/C	Iron
ICP	EPA 6010B/C	Lead
ICP	EPA 6010B/C	Magnesium
ICP	EPA 6010B/C	Manganese
CVAA	EPA 7471A/B	Mercury
ICP	EPA 6010B/C	Molybdenum
ICP	EPA 6010B/C	Nickel
ICP	EPA 6010B/C	Potassium
ICP	EPA 6010B/C	Selenium
ICP	EPA 6010B/C	Silver
ICP	EPA 6010B/C	Sodium
ICP	EPA 6010B/C	Strontium
ICP	EPA 6010B/C	Tin
ICP	EPA 6010B/C	Titanium
ICP	EPA 6010B/C	Thallium
ICP	EPA 6010B/C	Vanadium
ICP	EPA 6010B/C	Zinc
UV/Vis	EPA 7196A	Hexavalent Chromium
TOC	Lloyd Kahn	Total Organic Carbon
Colorimetric	EPA 353.2	Nitrocellulose
Colorimetric	EPA 9012A/B	Cyanide

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Certificate # L2226

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
Titration	Chap.7, Sect. 7.3.4 Mod.	Reactive Sulfide
Titration	EPA 9034	Sulfide
Probe	EPA 9045C/D	pH
Preparation	**Method**	**Type**
Preparation	EPA 1311	TCLP
Preparation	EPA 1312	SPLP
Preparation	NJ Modified 3060A	Hexavalent Chromium
Preparation	EPA 3050B	Metals Digestion
Preparation	EPA 3546	Organics Microwave Extraction
Preparation	EPA 3550B/C	Organics Sonication
Preparation	SM 2540B 20th/21st edition	Percent Solids (Percent Moisture)
Preparation	EPA 5035 /A	Purge and Trap Solid

Notes:

1) This laboratory offers commercial testing service.

Approved By: ______________________ Date: January 25, 2011

R. Douglas Leonard
Chief Technical Officer

Issued: 11/30/09 Revised: 2/9/10 Revised: 3/31/10 Revised: 10/8/10 Revised: 1/25/11

LABORATORY ACCREDITATION BUREAU

Certificate # L2226

Scope of Accreditation
For
Empirical Laboratories, LLC

621 Mainstream Drive, Suite 270
Nashville, TN 37228
Marcia K. McGinnity
1-877-345-1113

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.1) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to Empirical Laboratories, LLC to perform the following tests:

Accreditation granted through: **November 30, 2012**

Testing - Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,1-Trichloroethane (1,1,1-TCA)
GC/MS	EPA 8260B	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)
GC/MS	EPA 8260B	1,1,2-Trichloroethane
GC/MS	EPA 8260B	1,1-Dichloroethane (1,1-DCA)
GC/MS	EPA 8260B	1,1-Dichloroethene (1,1-DCE)
GC/MS	EPA 8260B	1,1-Dichloropropene
GC/MS	EPA 8260B	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B	1,2,3-Trichloropropane
GC/MS	EPA 8260B	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 8260B	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260B	1,2-Dichlorobenzene
GC/MS	EPA 8260B	1,2-Dichloroethane (EDC)
GC/MS	EPA 8260B	1,2-Dichloropropane
GC/MS	EPA 8260B	1,3,5-Trimethylbenzene

LABORATORY ACCREDITATION BUREAU

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8260B	1,3-Dichlorobenzene
GC/MS	EPA 8260B	1,3-Dichloropropane
GC/MS	EPA 8260B	1,4-Dichlorobenzene
GC/MS	EPA 8260B	1-Chlorohexane
GC/MS	EPA 8260B	2,2-Dichloropropane
GC/MS	EPA 8260B	2-Butanone (Methyl ethyl ketone; MEK)
GC/MS	EPA 8260B	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B	2-Chlorotoluene
GC/MS	EPA 8260B	2-Hexanone (Methyl butyl ketone; MBK)
GC/MS	EPA 8260B	4-Chlorotoluene
GC/MS	EPA 8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)
GC/MS	EPA 8260B	Acetone
GC/MS	EPA 8260B	Acrolein
GC/MS	EPA 8260B	Acrylonitrile
GC/MS	EPA 8260B	Benzene
GC/MS	EPA 8260B	Bromobenzene
GC/MS	EPA 8260B	Bromochloromethane
GC/MS	EPA 8260B	Bromodichloromethane
GC/MS	EPA 8260B	Bromoform
GC/MS	EPA 8260B	Bromomethane
GC/MS	EPA 8260B	Carbon Disulfide
GC/MS	EPA 8260B	Carbon Tetrachloride
GC/MS	EPA 8260B	Chlorobenzene
GC/MS	EPA 8260B	Chloroethane
GC/MS	EPA 8260B	Chloroform
GC/MS	EPA 8260B	Chloromethane
GC/MS	EPA 8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)
GC/MS	EPA 8260B	cis-1,3-Dichloropropene
GC/MS	EPA 8260B	Cyclohexane
GC/MS	EPA 8260B	Dibromochloromethane
GC/MS	EPA 8260B	Dibromomethane
GC/MS	EPA 8260B	Dichlorodifluoromethane (CFC-12)
GC/MS	EPA 8260B	Di-isopropyl ether

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B	ETBE
GC/MS	EPA 8260B	Ethyl methacrylate
GC/MS	EPA 8260B	Ethylbenzene
GC/MS	EPA 8260B	Hexachlorobutadiene
GC/MS	EPA 8260B	Iodomethane
GC/MS	EPA 8260B	Isopropylbenzene (Cumene)
GC/MS	EPA 8260B	Methyl Acetate
GC/MS	EPA 8260B	Methyl methacrylate
GC/MS	EPA 8260B	Methyl Tertiary Butyl Ether (MTBE)
GC/MS	EPA 8260B	Methylcyclohexane
GC/MS	EPA 8260B	Methylene Chloride, or Dichloromethane
GC/MS	EPA 8260B	Naphthalene
GC/MS	EPA 8260B	n-Butylbenzene
GC/MS	EPA 8260B	n-Propylbenzene
GC/MS	EPA 8260B	p-Isopropyltoluene
GC/MS	EPA 8260B	sec-Butylbenzene
GC/MS	EPA 8260B	Styrene
GC/MS	EPA 8260B	t-Butyl alcohol
GC/MS	EPA 8260B	tert-Amyl methyl ether
GC/MS	EPA 8260B	tert-Butylbenzene
GC/MS	EPA 8260B	Tetrachloroethene (PCE; PERC)
GC/MS	EPA 8260B	Tetrahydrofuran
GC/MS	EPA 8260B	Toluene
GC/MS	EPA 8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)
GC/MS	EPA 8260B	trans-1,3-Dichloropropene
GC/MS	EPA 8260B	Trichloroethene (TCE)
GC/MS	EPA 8260B	Trichlorofluoromethane (CFC-11)
GC/MS	EPA 8260B	Vinyl acetate
GC/MS	EPA 8260B	Vinyl Chloride (VC)
GC/MS	EPA 8260B	Xylenes (Total)
GC/MS	EPA 8270C/D	1,1'-Biphenyl
GC/MS	EPA 8270C/D	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D	1,2,4-Trichlorobenzene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	1,2-Dichlorobenzene
GC/MS	EPA 8270C/D	1,2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1,3-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dioxane
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D	2,4,6-Trichlorophenol (TCP)
GC/MS	EPA 8270C/D	2,4-Dichlorophenol (DCP)
GC/MS	EPA 8270C/D	2,4-Dimethylphenol
GC/MS	EPA 8270C/D	2,4-Dinitrophenol
GC/MS	EPA 8270C/D	2,4-Dinitrotoluene (DNT)
GC/MS	EPA 8270C/D	2,6-Dichlorophenol
GC/MS	EPA 8270C/D	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol (o-Cresol)
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 8270C/D	2-Nitrophenol (ONP)
GC/MS	EPA 8270C/D	3,3'-Dichlorobenzidine (DCB)
GC/MS	EPA 8270C/D	3-Methylphenol
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4,6-Dinitro-2-methylphenol (DNOC)
GC/MS	EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 8270C/D	4-Chlorophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Methylphenol (p-Cresol)
GC/MS	EPA 8270C/D	4-Nitroaniline (PNA)
GC/MS	EPA 8270C/D	4-Nitrophenol (PNP)
GC/MS	EPA 8270C/D	7,12-Dimethylbenz(a)anthracene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Acenaphthene
GC/MS	EPA 8270C/D	Acenaphthylene
GC/MS	EPA 8270C/D	Acetaphenone
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 8270C/D	Benzidine
GC/MS	EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D	Benzoic Acid
GC/MS	EPA 8270C/D	Benzyl alcohol
GC/MS	EPA 8270C/D	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270C/D	bis(2-Chloroethyl)ether (BCEE)
GC/MS	EPA 8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)
GC/MS	EPA 8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)
GC/MS	EPA 8270C/D	Butyl benzyl phthalate (BBP)
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole
GC/MS	EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Dibenz(a,h)anthracene
GC/MS	EPA 8270C/D	Dibenzofuran (DBF)
GC/MS	EPA 8270C/D	Diethyl phthalate (DEP)
GC/MS	EPA 8270C/D	Dimethyl phthalate (DMP)
GC/MS	EPA 8270C/D	Di-n-butyl phthalate (DBP)
GC/MS	EPA 8270C/D	Di-n-octyl phthalate (DNOP)
GC/MS	EPA 8270C/D	Fluoranthene
GC/MS	EPA 8270C/D	Fluorene
GC/MS	EPA 8270C/D	Hexachlorobenzene (HCB)

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Hexachlorobutadiene (HCBD)
GC/MS	EPA 8270C/D	Hexachlorocyclopentadiene (HCCPD)
GC/MS	EPA 8270C/D	Hexachloroethane (HCE)
GC/MS	EPA 8270C/D	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Naphthalene
GC/MS	EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	N-Nitrosodimethylamine
GC/MS	EPA 8270C/D	N-Nitroso-di-n-propylamine (NDPA)
GC/MS	EPA 8270C/D	N-nitrosodiphenylamine (NDPHA)
GC/MS	EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 8270C/D	Phenanthrene
GC/MS	EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/ECD	EPA 8081A/B	4,4'-DDD
GC/ECD	EPA 8081A/B	4,4'-DDE
GC/ECD	EPA 8081A/B	4,4'-DDT
GC/ECD	EPA 8081A/B	Aldrin
GC/ECD	EPA 8081A/B	alpha-BHC (alpha-HCH)
GC/ECD	EPA 8081A/B	alpha-Chlordane
GC/ECD	EPA 8081A/B	beta-BHC (beta-HCH)
GC/ECD	EPA 8081A/B	delta-BHC (delta-HCH)
GC/ECD	EPA 8081A/B	Dieldrin
GC/ECD	EPA 8081A/B	Endosulfan I
GC/ECD	EPA 8081A/B	Endosulfan II
GC/ECD	EPA 8081A/B	Endosulfan sulfate
GC/ECD	EPA 8081A/B	Endrin
GC/ECD	EPA 8081A/B	Endrin aldehyde
GC/ECD	EPA 8081A/B	Endrin ketone
GC/ECD	EPA 8081A/B	gamma-BHC (Lindane; gamma-HCH)
GC/ECD	EPA 8081A/B	gamma-Chlordane
GC/ECD	EPA 8081A/B	Heptachlor

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081A/B	Heptachlor epoxide
GC/ECD	EPA 8081A/B	Methoxychlor
GC/ECD	EPA 8081A/B	Chlordane
GC/ECD	EPA 8081A/B	Toxaphene
GC/ECD	EPA 8082 /A	Aroclor-1016
GC/ECD	EPA 8082 /A	Aroclor-1221
GC/ECD	EPA 8082 /A	Aroclor-1232
GC/ECD	EPA 8082 /A	Aroclor-1242
GC/ECD	EPA 8082 /A	Aroclor-1248
GC/ECD	EPA 8082 /A	Aroclor-1254
GC/ECD	EPA 8082 /A	Aroclor-1260
GC/ECD	EPA 8082 /A	Aroclor-1262
GC/ECD	EPA 8082 /A	Aroclor-1268
GC/ECD	EPA 8151A	2,4,5-T
GC/ECD	EPA 8151A	2,4,5-TP (Silvex)
GC/ECD	EPA 8151A	2,4-D
GC/ECD	EPA 8151A	2,4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichlorprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP (Mecoprop)
HPLC/UV	EPA 8330A/B	1,3,5-Trinitrobenzene
HPLC/UV	EPA 8330A/B	1,3-Dinitrobenzene
HPLC/UV	EPA 8330A/B	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	EPA 8330A/B	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	EPA 8330A/B	2,4-Dinitrotoluene (DNT)
HPLC/UV	EPA 8330A/B	2,6-Dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Amino-4,6-dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Nitrotoluene (ONT)
HPLC/UV	EPA 8330A/B	3,5-Dinitroaniline
HPLC/UV	EPA 8330A/B	3-Nitrotoluene

Non-Potable Water		
Technology	**Method**	**Analyte**
HPLC/UV	EPA 8330A/B	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330A/B	4-Nitrotoluene (PNT)
HPLC/UV	EPA 8330A/B	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	EPA 8330A/B	Nitrobenzene
HPLC/UV	EPA 8330A/B	Nitroglycerin
HPLC/UV	EPA 8330A/B	Nitroguanidine
HPLC/UV	EPA 8330A/B	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	EPA 8330A/B	3,5-Dinitroaniline
HPLC/UV	EPA 8330A/B	PETN
GC/FID	FLPRO	Petroleum Range Organics
GC/FID	EPA 8015B	TPH DRO
GC/FID	EPA 8015B	TPH GRO
GC/FID	RSK-175	Methane
GC/FID	RSK-175	Ethane
GC/FID	RSK-175	Ethene
GC/ECD	EPA 8011	1,2-Dibromoethane (EDB)
GC/ECD	EPA 8011	1,2-Dibromo-3-chloropropane (DBCP)
HPLC/MS	EPA 6850	Perchlorate
ICP	EPA 6010B/C	Aluminum
ICP	EPA 6010B/C	Antimony
ICP	EPA 6010B/C	Arsenic
ICP	EPA 6010B/C	Barium
ICP	EPA 6010B/C	Beryllium
ICP	EPA 6010B/C	Boron
ICP	EPA 6010B/C	Cadmium
ICP	EPA 6010B/C	Calcium
ICP	EPA 6010B/C	Chromium, total
ICP	EPA 6010B/C	Cobalt
ICP	EPA 6010B/C	Copper
ICP	EPA 6010B/C	Iron
ICP	EPA 6010B/C	Lead
ICP	EPA 6010B/C	Magnesium
ICP	EPA 6010B/C	Manganese

Non-Potable Water		
Technology	**Method**	**Analyte**
CVAA	EPA 6010B/C	Mercury
ICP	EPA 6010B/C	Molybdenum
ICP	EPA 6010B/C	Nickel
ICP	EPA 6010B/C	Potassium
ICP	EPA 6010B/C	Selenium
ICP	EPA 6010B/C	Silver
ICP	EPA 6010B/C	Sodium
ICP	EPA 6010B/C	Strontium
ICP	EPA 6010B/C	Thallium
ICP	EPA 6010B/C	Tin
ICP	EPA 6010B/C	Titanium
ICP	EPA 6010B/C	Vanadium
ICP	EPA 6010B/C	Zinc
IC	EPA 300.0	Chloride
IC	EPA 300.0	Fluoride
IC	EPA 300.0	Nitrate
IC	EPA 300.0	Nitrite
IC	EPA 300.0	Sulfate
IC	EPA 9056A	Chloride
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Nitrate
IC	EPA 9056A	Nitrite
IC	EPA 9056A	Sulfate
Titration	SM 2320B 20th/21st edition	Alkalinity
Colorimetric	SM 4500 B, G, 20th/21st edition	Ammonia
UV/Vis	EPA 7196A	Hexavalent Chromium
Colorimetric	EPA 353.2	Nitrocellulose
Colorimetric	EPA 353.2	Nitrate/Nitrite
Titration	Chap.7, Sect. 7.3.4 Mod.	Reactive Sulfide
Titration	SM 4500 S-2CF, 20th/21st edition	Sulfide
UV/Vis	SM 4500 P B5, E, 20th/21st edition	Total Phosphorus (as P)

Non-Potable Water		
Technology	**Method**	**Analyte**
UV/Vis	SM 4500 PE, 20th/21st edition	Ortho-Phosphate (as P)
TOC	9060A/SM5310C, 20th/21st edition	Total Organic Carbon
Gravimetric	SM 2540C, 20th/21st edition	TDS
Colorimetric	EPA 9012A/B	Cyanide
Physical	EPA 1010A	Ignitability
Physical	EPA 9095B	Paint Filter
Probe	EPA 9040B/C	pH
Preparation	**Method**	**Type**
Preparation	EPA 1311	TCLP
Preparation	EPA 3005A	Metals digestion
Preparation	EPA 3010A	Metals digestion
Preparation	EPA 3510C	Organics Liquid Extraction
Preparation	EPA 5030A/B	Purge and Trap Water

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B	1,1,1-Trichloroethane (1,1,1-TCA)
GC/MS	EPA 8260B	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)
GC/MS	EPA 8260B	1,1,2-Trichloroethane
GC/MS	EPA 8260B	1,1-Dichloroethane (1,1-DCA)
GC/MS	EPA 8260B	1,1-Dichloroethene (1,1-DCE)
GC/MS	EPA 8260B	1,1-Dichloropropene
GC/MS	EPA 8260B	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B	1,2,3-Trichloropropane
GC/MS	EPA 8260B	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 8260B	1,2-Dibromoethane (EDB)

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	EPA 8260B	1,2-Dichlorobenzene
GC/MS	EPA 8260B	1,2-Dichloroethane (EDC)
GC/MS	EPA 8260B	1,2-Dichloropropane
GC/MS	EPA 8260B	1,3,5-Trimethylbenzene
GC/MS	EPA 8260B	1,3-Dichlorobenzene
GC/MS	EPA 8260B	1,3-Dichloropropane
GC/MS	EPA 8260B	1,4-Dichlorobenzene
GC/MS	EPA 8260B	2,2-Dichloropropane
GC/MS	EPA 8260B	2-Butanone (Methyl ethyl ketone; MEK)
GC/MS	EPA 8260B	2-Chlorotoluene
GC/MS	EPA 8260B	2-Hexanone (Methyl butyl ketone; MBK)
GC/MS	EPA 8260B	4-Chlorotoluene
GC/MS	EPA 8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)
GC/MS	EPA 8260B	Acetone
GC/MS	EPA 8260B	Acrolein
GC/MS	EPA 8260B	Acrylonitrile
GC/MS	EPA 8260B	Benzene
GC/MS	EPA 8260B	Bromobenzene
GC/MS	EPA 8260B	Bromochloromethane
GC/MS	EPA 8260B	Bromodichloromethane
GC/MS	EPA 8260B	Bromoform
GC/MS	EPA 8260B	Bromomethane
GC/MS	EPA 8260B	Carbon Disulfide
GC/MS	EPA 8260B	Carbon Tetrachloride
GC/MS	EPA 8260B	Chlorobenzene
GC/MS	EPA 8260B	Chloroethane
GC/MS	EPA 8260B	Chloroform
GC/MS	EPA 8260B	Chloromethane
GC/MS	EPA 8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)
GC/MS	EPA 8260B	cis-1,3-Dichloropropene
GC/MS	EPA 8260B	Cyclohexane
GC/MS	EPA 8260B	Dibromochloromethane

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B	Dibromomethane
GC/MS	EPA 8260B	Dichlorodifluoromethane (CFC-12)
GC/MS	EPA 8260B	Ethyl methacrylate
GC/MS	EPA 8260B	Ethylbenzene
GC/MS	EPA 8260B	Hexachlorobutadiene
GC/MS	EPA 8260B	Iodomethane
GC/MS	EPA 8260B	Isopropylbenzene (Cumene)
GC/MS	EPA 8260B	Methyl Acetate
GC/MS	EPA 8260B	Methyl methacrylate
GC/MS	EPA 8260B	Methyl Tertiary Butyl Ether (MTBE)
GC/MS	EPA 8260B	Methylcyclohexane
GC/MS	EPA 8260B	Methylene Chloride, or Dichloromethane
GC/MS	EPA 8260B	Naphthalene
GC/MS	EPA 8260B	n-Butylbenzene
GC/MS	EPA 8260B	n-Propylbenzene
GC/MS	EPA 8260B	p-Isopropyltoluene
GC/MS	EPA 8260B	sec-Butylbenzene
GC/MS	EPA 8260B	Styrene
GC/MS	EPA 8260B	tert-Butylbenzene
GC/MS	EPA 8260B	Tetrachloroethene (PCE; PERC)
GC/MS	EPA 8260B	Toluene
GC/MS	EPA 8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)
GC/MS	EPA 8260B	trans-1,3-Dichloropropene
GC/MS	EPA 8260B	Trichloroethene (TCE)
GC/MS	EPA 8260B	Trichlorofluoromethane (CFC-11)
GC/MS	EPA 8260B	Vinyl acetate
GC/MS	EPA 8260B	Vinyl Chloride (VC)
GC/MS	EPA 8260B	Xylenes (Total)
GC/MS	EPA 8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)
GC/MS	EPA 8270C/D	1,1'-Biphenyl
GC/MS	EPA 8270C/D	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D	1,2,4-Trichlorobenzene

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	1,2-Dichlorobenzene
GC/MS	EPA 8270C/D	1,2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1,3-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dioxane
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D	2,4,6-Trichlorophenol (TCP)
GC/MS	EPA 8270C/D	2,4-Dichlorophenol (DCP)
GC/MS	EPA 8270C/D	2,4-Dimethylphenol
GC/MS	EPA 8270C/D	2,4-Dinitrophenol
GC/MS	EPA 8270C/D	2,4-Dinitrotoluene (DNT)
GC/MS	EPA 8270C/D	2,6-Dichlorophenol
GC/MS	EPA 8270C/D	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol (o-Cresol)
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 8270C/D	2-Nitrophenol (ONP)
GC/MS	EPA 8270C/D	3,3'-Dichlorobenzidine (DCB)
GC/MS	EPA 8270C/D	3-Methylphenol
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4,6-Dinitro-2-methylphenol (DNOC)
GC/MS	EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 8270C/D	4-Chlorophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Methylphenol (p-Cresol)
GC/MS	EPA 8270C/D	4-Nitroaniline (PNA)
GC/MS	EPA 8270C/D	4-Nitrophenol (PNP)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Acenaphthene
GC/MS	EPA 8270C/D	Acenaphthylene
GC/MS	EPA 8270C/D	Acetaphenone
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 8270C/D	Benzidine
GC/MS	EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D	Benzoic Acid
GC/MS	EPA 8270C/D	Benzyl alcohol
GC/MS	EPA 8270C/D	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270C/D	bis(2-Chloroethyl)ether (BCEE)
GC/MS	EPA 8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)
GC/MS	EPA 8270C/D	Butyl benzyl phthalate (BBP)
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole
GC/MS	EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Dibenz(a,h)anthracene
GC/MS	EPA 8270C/D	Dibenzofuran (DBF)
GC/MS	EPA 8270C/D	Diethyl phthalate (DEP)
GC/MS	EPA 8270C/D	Dimethyl phthalate (DMP)
GC/MS	EPA 8270C/D	Di-n-butyl phthalate (DBP)
GC/MS	EPA 8270C/D	Di-n-octyl phthalate (DNOP)
GC/MS	EPA 8270C/D	Fluoranthene
GC/MS	EPA 8270C/D	Fluorene
GC/MS	EPA 8270C/D	Hexachlorobenzene (HCB)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Hexachlorobutadiene (HCBD)
GC/MS	EPA 8270C/D	Hexachlorocyclopentadiene (HCCPD)
GC/MS	EPA 8270C/D	Hexachloroethane (HCE)
GC/MS	EPA 8270C/D	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Naphthalene
GC/MS	EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	N-Nitrosodimethylamine
GC/MS	EPA 8270C/D	N-Nitroso-di-n-propylamine (NDPA)
GC/MS	EPA 8270C/D	N-nitrosodiphenylamine (NDPHA)
GC/MS	EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 8270C/D	Phenanthrene
GC/MS	EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/ECD	EPA 8081A/B	4,4'-DDD
GC/ECD	EPA 8081A/B	4,4'-DDE
GC/ECD	EPA 8081A/B	4,4'-DDT
GC/ECD	EPA 8081A/B	Aldrin
GC/ECD	EPA 8081A/B	alpha-BHC (alpha-HCH)
GC/ECD	EPA 8081A/B	alpha-Chlordane
GC/ECD	EPA 8081A/B	beta-BHC (beta-HCH)
GC/ECD	EPA 8081A/B	delta-BHC (delta-HCH)
GC/ECD	EPA 8081A/B	Chlordane
GC/ECD	EPA 8081A/B	Dieldrin
GC/ECD	EPA 8081A/B	Endosulfan I
GC/ECD	EPA 8081A/B	Endosulfan II
GC/ECD	EPA 8081A/B	Endosulfan sulfate
GC/ECD	EPA 8081A/B	Endrin
GC/ECD	EPA 8081A/B	Endrin aldehyde
GC/ECD	EPA 8081A/B	Endrin ketone
GC/ECD	EPA 8081A/B	gamma-BHC (Lindane; gamma-HCH)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081A/B	gamma-Chlordane
GC/ECD	EPA 8081A/B	Heptachlor
GC/ECD	EPA 8081A/B	Heptachlor epoxide
GC/ECD	EPA 8081A/B	Methoxychlor
GC/ECD	EPA 8081A/B	Toxaphene
GC/ECD	EPA 8082 /A	Aroclor-1016
GC/ECD	EPA 8082 /A	Aroclor-1221
GC/ECD	EPA 8082 /A	Aroclor-1232
GC/ECD	EPA 8082 /A	Aroclor-1242
GC/ECD	EPA 8082 /A	Aroclor-1248
GC/ECD	EPA 8082 /A	Aroclor-1254
GC/ECD	EPA 8082 /A	Aroclor-1260
GC/ECD	EPA 8082 /A	Aroclor-1262
GC/ECD	EPA 8082 /A	Aroclor-1268
GC/ECD	EPA 8151A	2,4,5-T
GC/ECD	EPA 8151A	2,4,5-TP (Silvex)
GC/ECD	EPA 8151A	2,4-D
GC/ECD	EPA 8151A	2,4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichlorprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP (Mecoprop)
HPLC/UV	EPA 8330A	1,3,5-Trinitrobenzene
HPLC/UV	EPA 8330A	1,3-Dinitrobenzene
HPLC/UV	EPA 8330A	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	EPA 8330A	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	EPA 8330A	2,4-Dinitrotoluene (DNT)
HPLC/UV	EPA 8330A	2,6-Dinitrotoluene
HPLC/UV	EPA 8330A	2-Amino-4,6-dinitrotoluene
HPLC/UV	EPA 8330A	2-Nitrotoluene (ONT)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
HPLC/UV	EPA 8330A	3-Nitrotoluene
HPLC/UV	EPA 8330A	3,5-Dinitroaniline
HPLC/UV	EPA 8330A	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330A	4-Nitrotoluene (PNT)
HPLC/UV	EPA 8330A	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	EPA 8330A	Nitroglycerin
HPLC/UV	EPA 8330A	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	EPA 8330A	Nitrobenzene
HPLC/UV	EPA 8330A	Nitroguanidine
HPLC/UV	EPA 8330A	PETN
HPLC/UV	EPA 8330B	1,3,5-Trinitrobenzene
HPLC/UV	EPA 8330B	1,3-Dinitrobenzene
HPLC/UV	EPA 8330B	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	EPA 8330B	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	EPA 8330B	2,4-Dinitrotoluene (DNT)
HPLC/UV	EPA 8330B	2,6-Dinitrotoluene
HPLC/UV	EPA 8330B	2-Amino-4,6-dinitrotoluene
HPLC/UV	EPA 8330B	2-Nitrotoluene (ONT)
HPLC/UV	EPA 8330B	3-Nitrotoluene
HPLC/UV	EPA 8330B	3,5-Dinitroaniline
HPLC/UV	EPA 8330B	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330B	4-Nitrotoluene (PNT)
HPLC/UV	EPA 8330B	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	EPA 8330B	Nitroglycerin
HPLC/UV	EPA 8330B	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	EPA 8330B	Nitrobenzene
HPLC/UV	EPA 8330B	Nitroguanidine
HPLC/UV	EPA 8330B	PETN
GC/FID	FLPRO	Petroleum Range Organics
GC/FID	EPA 8015B	TPH DRO
GC/FID	EPA 8015B	TPH GRO
HPLC/MS	EPA 6850	Perchlorate

Solid and Chemical Materials

Technology	Method	Analyte
ICP	EPA 6010B/C	Aluminum
ICP	EPA 6010B/C	Antimony
ICP	EPA 6010B/C	Arsenic
ICP	EPA 6010B/C	Barium
ICP	EPA 6010B/C	Beryllium
ICP	EPA 6010B/C	Boron
ICP	EPA 6010B/C	Cadmium
ICP	EPA 6010B/C	Calcium
ICP	EPA 6010B/C	Chromium, total
ICP	EPA 6010B/C	Cobalt
ICP	EPA 6010B/C	Copper
ICP	EPA 6010B/C	Iron
ICP	EPA 6010B/C	Lead
ICP	EPA 6010B/C	Magnesium
ICP	EPA 6010B/C	Manganese
CVAA	EPA 7471A/B	Mercury
ICP	EPA 6010B/C	Molybdenum
ICP	EPA 6010B/C	Nickel
ICP	EPA 6010B/C	Potassium
ICP	EPA 6010B/C	Selenium
ICP	EPA 6010B/C	Silver
ICP	EPA 6010B/C	Sodium
ICP	EPA 6010B/C	Strontium
ICP	EPA 6010B/C	Tin
ICP	EPA 6010B/C	Titanium
ICP	EPA 6010B/C	Thallium
ICP	EPA 6010B/C	Vanadium
ICP	EPA 6010B/C	Zinc
UV/Vis	EPA 7196A	Hexavalent Chromium
TOC	Lloyd Kahn	Total Organic Carbon
Colorimetric	EPA 353.2	Nitrocellulose
Colorimetric	EPA 9012A/B	Cyanide

LABORATORY ACCREDITATION BUREAU

Certificate # L2226

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
Titration	Chap.7, Sect. 7.3.4 Mod.	Reactive Sulfide
Titration	EPA 9034	Sulfide
Probe	EPA 9045C/D	pH
Preparation	**Method**	**Type**
Preparation	EPA 1311	TCLP
Preparation	EPA 1312	SPLP
Preparation	NJ Modified 3060A	Hexavalent Chromium
Preparation	EPA 3050B	Metals Digestion
Preparation	EPA 3546	Organics Microwave Extraction
Preparation	EPA 3550B/C	Organics Sonication
Preparation	SM 2540B 20th/21st edition	Percent Solids (Percent Moisture)
Preparation	EPA 5035 /A	Purge and Trap Solid

Notes:

1) This laboratory offers commercial testing service.

Approved By: R.D.

R. Douglas Leonard
Chief Technical Officer

Date: January 25, 2011

Issued: 11/30/09 Revised: 2/9/10 Revised: 3/31/10 Revised: 10/8/10 Revised: 1/25/11

Appendix C
Project Scoping Sessions

June 2010 - Project Scoping Session Participants Sheet

Project Name: Yorktown Site 7 Expanded Remedial Investigation (ERI) **Projected Date(s) of Sampling:** Spring 2011 **PM:** Adam Forshey (at the time of the scoping session)	**Site Name:** Site 7 **Site Location:** WPNSTA Yorktown, Virginia
Date of Session: June 23, 2010 **Scoping Session Purpose:** To review previous investigation data and present the proposed sampling approach to the Partnering team for Site 7 sample locations.	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Bill Friedmann	AM	CH2M HILL	757-671-6223	william.friedmann@ch2m.com	Overseeing project delivery, technical support
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Rob Thomson	RPM	USEPA	215-814-3357	Thomson.Bob@epamail.epa.gov	Lead representative of USEPA, responsible for review of documents and ensure that appropriate regulations are applied
Wade Smith	RPM	VDEQ	804 698-4125	wade.smith@deq.virginia.gov	Lead representative of VDEQ, responsible for review of documents and ensure that appropriate regulations are applied
Tom Kowalski	RPM	NAVFAC Mid-Atlantic	757-341-0479	Tom.Kowalski@navy.mil	Representative of lead agency responsible for overseeing execution of projects

Comments/Decisions:

The purpose of the scoping session was to provide the team with the previous data at the site to determine what additional sampling is needed in order to plan for a UFP-SAP. The team discussed the site history and the recent demolition of all existing buildings at Site 7. Rob requested that the former footprints of the recently demolished loading plants be investigated because these areas were not sampled during previous rounds and are likely potential sources of contamination at the site. Rob also requested that construction drawings of the facilities be obtained and considered when placing sample locations. Tom agreed to look for a demolition report for the site and CH2M HILL agreed to research construction drawings.

The team discussed possibly completing direct push technology (DPT) surface soil, subsurface soil and groundwater samples in the vicinity of the former building footprint and installing new monitoring wells based on the results of the DPT sampling. Wade noted that another groundwater well around Building 505 should also be installed.

Action Items:

- CH2M HILL agreed to look for construction plans which show the processes performed in the buildings at Site 7 to assist in planning sampling activities at Site 7.
- Tom agreed to look for demolition reports for the building/work done at Site 7 which will help to determine sample locations.

Consensus Decisions:

- The team agreed to the proposed path forward and requested that the approach be revisited once action items were completed.

Outcome

- Building uses were determined and were used for sample location selection as discussed in **Worksheet #10**

September 2010 - Project Scoping Session Participants Sheet

Project Name: Yorktown Site 7 ERI **Projected Date(s) of Sampling:** Spring 2011 **PM:** Adam Forshey				**Site Name:** Site 7 **Site Location:** WPNSTA Yorktown, Virginia	
Date of Session: September 2010 **Scoping Session Purpose:** To review previous investigation data and present the proposed sampling approach to the Partnering team for Site 7 sample locations.					
Name	**Title**	**Affiliation**	**Phone #**	**E-mail Address**	**Project Role**
Bill Friedmann	AM	CH2M HILL	757-671-6223	william.friedmann@ ch2m.com	Overseeing project delivery, technical support
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Laura Cook	AQM and STC	CH2M HILL	757-671-6214	laura.cook@ ch2m.com	Overseeing project delivery, technical support
Jason Mills	Staff Engineer	CH2M HILL	757-671-6270	jason.mills@ ch2m.com	UFP-SAP production

Comments/Decisions:

The CH2M HILL team reviewed the previous sample results/investigations and a proposed sampling approach for Site 7. The approach and decisions made were internal and preliminary, and were ultimately discussed with the Navy and, subsequently, the remainder of the Partnering Team. It was noted that although the buildings have been demolished, the soil berms are still in place. The groundwater flow and existing well network was discussed. The team considered proposing a grid type sampling approach along the location of the demolished buildings and conveyors. The sampling strategy included eight primary DPT surface soil, subsurface soil and groundwater samples to be collected initially. If detections of VOCs or explosives were identified in the primary sample locations, adjacent secondary sample locations would be collected on a 100-foot offset grid. The results of the sampling grid were to be used to identify the locations for permanent monitoring wells in the vicinity of the conveyor. It was assumed that three new permanent wells would be installed in this area. A new permanent monitoring well was also planned in the vicinity of Buildings 504 and 505. Two additional wells were proposed for installation along the eastern perimeter of the site for the purpose of collecting upgradient reference samples.

A similar grid approach was suggested for the surface water and sediment sample locations in the marsh wetland downgradient of Building 503. The proposed sediment and surface water approach consisted of five initial samples and four contingency samples in the sediment west of the discharge and one additional primary sample and one contingency sample to be collected in the tributary downgradient of Building 502.

The team noted that a 24-hour turnaround time would be necessary on the primary samples to reduce down time for DPT crew. A review of the data would then need to be performed to determine where additional secondary sampling is necessary.

Based upon the discussion the team recommended the following analytical parameters for analysis at Site 7:

- Surface and Subsurface Soil – Target Compound List (TCL) VOCs, explosives, and Target Analyte List (TAL) metals and cyanide
- Groundwater – TCL VOCs, explosives (including perchlorate), TAL total and dissolved metals and cyanide
- Surface Water – TCL VOCs, explosives, TAL total and dissolved metals and cyanide
- Sediment – TCL VOCs, explosives, TAL metals and cyanide

In review of the historical activities and data collected from the site, there is no evidence to support the sampling for polychlorinated biphenyls (PCBs) or pesticides based on site usage. Semivolatile organic compounds (SVOCs) will also not be included as historical data indicate that the only detections of SVOCs were likely related to laboratory contaminants.

Action Items:

- Include discussion of site use in the Site 7 background, to support not including PCBs, pesticides, and SVOCs as parameters.

Consensus Decisions:

- The internal CH2M HILL team agreed to the sampling approach and analytical parameters.

Outcome:

The sampling approach discussed during this meeting was significantly changed following the fourth and fifth (external) scoping sessions.

October 2010 - Project Scoping Session Participants Sheet

Project Name: Yorktown Site 7 ERI **Projected Date(s) of Sampling:** Spring 2011 **PM:** Adam Forshey				**Site Name:** Site 7 **Site Location:** WPNSTA Yorktown, Virginia	
Date of Session: October 13, 2010 **Scoping Session Purpose:** To review previous investigation data and present the proposed sampling approach to the Partnering team for Site 7 sample locations.					
Name	**Title**	**Affiliation**	**Phone #**	**E-mail Address**	**Project Role**
Bill Friedmann	AM	CH2M HILL	757-671-6223	william.friedmann@ch2m.com	Overseeing project delivery, technical support
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Rob Thomson	RPM	USEPA	215-814-3357	Thomson.Bob@epamail.epa.gov	Lead representative of USEPA, responsible for review of documents and ensure that appropriate regulations are applied
Wade Smith	RPM	VDEQ	804 698-4125	wade.smith@deq.virginia.gov	Lead representative of VDEQ, responsible for review of documents and ensure that appropriate regulations are applied
Tom Kowalski	RPM	NAVFAC Mid-Atlantic	757-341-0479	Tom.Kowalski@navy.mil	Representative of lead agency responsible for overseeing execution of projects

Comments/Decisions:

Adam provided the team with an update of Site 7 since the previous review of the sites during the June meeting. Since that time, information regarding the building functions and designs were located and provided a greater understanding of potential source areas. The team discussed the building usage and the sampling approach considered during CH2M HILL's internal scoping session. The sampling approach was approved with a few additional requirements.

In order to identify potential ecological receptors and transport pathways, the team agreed to a site visit with ecological technical support staff from each stakeholder agency; referred to as the ETSG prior to finalizing the sediment and surface water sample locations. Rob also suggested looking at all existing data for Site 7 to verify whether PCBs and pesticides were ever sampled for or were detected to make a decision on whether these parameters need to be included in the SAP. CH2M HILL and the Navy indicated that sampling for PCBs and pesticides should not be necessary, even if they have not been sampled for in the past because there is no history of a release of these chemicals at this site. However, Rob indicated that samples for these chemicals would be required because full suite analysis is necessary for CERCLA sites. CH2M HILL agreed to review previous data for Site 7 to determine if PCBs and/or pesticides were sampled for and found. Rob reiterated that if no data are available for these parameters, they will need to be included in the SAP. However, SVOC data are available and the data are indicative of lab contaminants except for one location which contained a polynuclear aromatic hydrocarbon (PAH) prior to the Pilot Study. Upon removal (after the Pilot Study) a sample was collected from the same location and the PAH was no longer present. The Team agreed that SVOCs did not need to be included in the parameters.

Action Items:

- Research whether pesticides/PCBs were collected previously and include sampling for these parameters if no existing data are available.

Consensus Decisions:

- The team agreed to the sampling approach and analytical parameters with the exception of potential changes based on the noted action item.

February 2011 - Project Scoping Session Participants Sheet

Project Name: Yorktown Site 7 ERI **Projected Date(s) of Sampling:** Spring/Summer 2011 **PM:** Adam Forshey				**Site Name:** Site 7 **Site Location:** WPNSTA Yorktown, Virginia	
Date of Session: February 3, 2011 and February 23, 2011 **Scoping Session Purpose:** To visit Site 7 and evaluate the proposed sampling approach.					
Name	**Title**	**Affiliation**	**Phone #**	**E-mail Address**	**Project Role**
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Rob Thomson	RPM	USEPA	215-814-3357	thomson.bob@epamail.epa.gov	Lead representative of USEPA, responsible for review of documents and ensure that appropriate regulations are applied
Wade Smith	RPM	VDEQ	804-698-4125	wade.smith@deq.virginia.gov	Lead representative of VDEQ, responsible for review of documents and ensure that appropriate regulations are applied
Tom Kowalski	RPM	NAVFAC Mid-Atlantic	757-341-0479	tom.kowalski@navy.mil	Representative of lead agency responsible for overseeing execution of projects
Dave Barclift	ETSG	NAVFAC Atlantic	215-897-4913	david.barclift@navy.mil	Ecological support from the Navy
John McCloskey	ESTG	EPA BTAG	804-693-6694	john_mccloskey@fws.gov	Ecological support from EPA
Kyle Newman	ESTG	VDEQ	804-698-4452	kyle.newman@deq.virginia.gov	Ecological support from VDEQ
Bill Kappleman	ESTG	CH2M HILL	703-376-5652	william.kappleman@ch2m.com	Ecological support from CH2M HILL

February 3, 2011 Site Visit

Comments/Decisions:

In order to identify optimal locations to address ecological concerns, the Yorktown Tier I Partnering team and technical support staff from ESTG walked the site, focusing on the southern site boundary with Felgates Creek in the eastern, central, and west-central areas of the site. A number of potential drainage pathways (eroded channels within the bank) were noted, as were several possible seeps (wet but not obviously flowing). Several residual structures were also observed:

- A drainage pipe in a retaining wall south of the location of former Building 2008
- A collapsed drainage pipe leading to a defined drainage channel in the west-central portion of the site

- A number of sewer covers approximately along the line of the former conveyor structure
- A possible sump-like structure near the location of structure 1904 on the site maps

Following the site walk, a brief discussion occurred. It was recommended that:
- The entire southern end of the site be observed in detail to map out potential drainage pathways (including residual piping) and seep locations. This should occur in March or April, depending upon rainfall, when seeps are most likely to be flowing.
- The sewer utility line and the sump-like structure should be investigated to determine if they pose a possible transport pathway and/or a source of residual contamination.
- Groundwater and soil sampling should proceed as originally scoped.

Once groundwater data (from permanent monitoring wells, not just DPT) and soil data, and the results of the site reconnaissance are available, this information should be used to select sample locations for seeps and pore water. Results of soil, groundwater, pore water and seeps data will be used to determine likely contaminant transport pathways and determine the locations of surface water and sediment samples, if determined to be necessary. Surface water, sediment, seep, and (if warranted) pore water samples would be collected in spring 2012 during the time period when seeps are most likely to flow if the results of the soil and groundwater investigations warrant.

Action Items:
- Complete seeps survey in March or April
- Further evaluate the sewer utility line and sump to determine if they could be a potential transport pathway

Consensus Decisions:
- The team agreed to the initial soil and groundwater sampling approach, but requested that all of the seeps, pore water, surface water and sediment sample locations and analytical parameters be selected following receipt of the soil and groundwater results and completion of the action items.

February 23, 2011 Follow-up Conference Call

Comments/Decisions:
A conference call was held with the team to discuss information from the actions items created in response to the February 3, 2011 site visit. Bill Friedman, Adam Forshey, Rob Thomson, Wade Smith, and Tom Kowalski held a conference call on February 23, 2011 to discuss how to focus the initial and contingency soil and groundwater sampling approach to reduce cost, in response to the action items created following the February 3, 2011 site visit. Following a detailed review of data, it was determined that perchlorates and 3,5-dinitroaniline were also potential contaminants at Site 7 and should be evaluated as part of the ERI. Due to the addition of these chemicals, the initial primary and secondary grid approach with quick turn-around sampling was excessively expensive and the team wanted to discuss other more affordable potential sampling approaches that would not compromise the quality of the investigation. The team agreed that surface and subsurface soil only would be collected at the initial eight sample locations in the vicinity of the buildings where explosives were handled and stored at the site. These samples would be analyzed for VOCs, explosives, pesticides/PCBs, metals, 3,5-dinitroaniline and perchlorate. Following receipt of the

sample data, the team would screen data against background concentrations, ecological screening values and regional screening levels (RSLs) and select up to ten additional contingency locations for soil sampling in addition to three monitoring well locations. Rob suggested that three tentative monitoring well locations be selected in this area in the event that there were no notable concentrations of contaminants in soil. The rationale for this is due to the possibility that contaminants have migrated into groundwater and are no longer present in soil. The original approach of soil sampling between Buildings 504 and 505 and installation of upgradient wells was not modified.

Action Items:

- Revise the draft SAP to eliminate the grid approach, incorporate the team’s decision, and submit the draft UFP-SAP for review

Consensus Decisions:

- The team agreed to the revised initial soil and groundwater sampling approach.

January 2012 - Project Scoping Session Participants Sheet

Project Name: Yorktown Site 7 ERI **Projected Date(s) of Sampling:** Fall 2012 **PM:** Adam Forshey				**Site Name:** Site 7 **Site Location:** WPNSTA Yorktown, Virginia	
Date of Session: January 5, 2012 **Scoping Session Purpose:** To review and discuss the response to comments on the Draft UFP-SAP and clarify the direction of the document for the project team					
Name	**Title**	**Affiliation**	**Phone #**	**E-mail Address**	**Project Role**
Bill Friedmann	AM	CH2M HILL	757-671-6223	william.friedmann@ch2m.com	Overseeing project delivery, technical support
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Wade Smith	RPM	VDEQ	804-698-4125	wade.smith@deq.virginia.gov	Lead representative of VDEQ, responsible for review of documents and ensure that appropriate regulations are applied
Jim Gravette	RPM	NAVFAC Mid-Atlantic	757-341-0479	Jim.Gravette@navy.mil	Representative of lead agency responsible for overseeing execution of projects

January 5, 2012 Conference Call

Comments/Decisions:

Bill Friedmann, Adam Forshey, Jim Gravette, Wade Smith, and Moshood Oduwole held a technical conference call on January 5, 2012 to review and discuss the response to comments on the Draft Site 7 UFP-SAP and clarify the direction the responses are headed for the Partnering Team. At the start of the conference call the group reviewed the different processes that were performed in each of the former buildings within Site 7, and noted that Building 502 was the only building that contained floor drains. In order to clarify the site characteristics it was requested that the red dashed line on appropriate figures be extended continuously from Building 502 to Building 375.

Prior to discussing the comments on the draft, it was noted that the initial sampling plan was recommended during the site visit with BTAG and the ecological technical support group on February 3, 2011. The Team then began to discuss specific comments. Some of the comments questioned the limitations of the sampling approach (not enough samples), if the study are had been adequately sampled, and recommended composite sampling throughout the former building footprint areas; however, it was noted that composite sampling is not useful for performing risk screening. It was proposed that instead of collecting composite soil samples, a number of discrete soil samples could be collected from the site. In addition to adding more samples, a summary in the form of a table would be provided in the SAP detailing why sample locations were selected. Although BTAG requested a minimum of 5 point composite samples, it was anticipated that the increase in grab sample locations would fulfill this request.

Another comment specifically addressed the plan to collect samples in a phased approach, which BTAG indicated was not appropriate. The Navy was concerned with this comment because it was different from what was previously agreed upon and has implications for other sites/sampling approaches. BTAG expressed that the seep samples and groundwater samples needed to be collected at the same time, because collecting them at different times would not give a real-time comparison. The assumption provided by BTAG is that the surface water and sediment have been impacted, while the assumption in the SAP is that the problem has not yet been determined. It was proposed that the phased approach remain, collecting groundwater and soil samples first, and then collecting an additional round of groundwater samples at the same time as seep samples if seep samples are determined to be necessary, at which time surface and sediment samples would also be collected.

The contaminant analysis in the SAP was also discussed, proposing that full suite needs to be performed, particularly for PAHs. The Partnering Team had previously agreed that based on previous analysis SVOCs were not a concern, as documented in the SAP.

The possibility of recontamination of the previous remediated drainage area was discussed and it was proposed that the Navy review previous investigation data to determine if this was a concern, and to add the footprint of the previous removal area to the proposed sampling locations.

Another comment suggested using SSLs to determine if there is a possibility for leaching to groundwater present, which is not currently identified in the SAP and was possibly overlooked by reviewers.

A review of the schedule and path forward, resulted in suggesting expediting the response to comments to the regulators and coordinating with the regulators technical support so that it can be discussed during the February Partnering Team meeting.

February 2012 - Project Scoping Session Participants Sheet

Project Name: Yorktown Site 7 ERI **Projected Date(s) of Sampling:** Fall 2012 **PM:** Adam Forshey	**Site Name:** Site 7 **Site Location:** WPNSTA Yorktown, Virginia
Date of Session: February 22 and 23, 2012 **Scoping Session Purpose:** To focus the initial and contingency soil and groundwater sampling approach to reduce cost.	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
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Wade Smith	RPM	VDEQ	804-698-4125	wade.smith@deq.virginia.gov	Lead representative of VDEQ, responsible for review of documents and ensure that appropriate regulations are applied
Jim Gravette	RPM	NAVFAC Mid-Atlantic	757-341-0479	Jim.Gravette@navy.mil	Representative of lead agency responsible for overseeing execution of projects
John McCloskey	ETSG	EPA BTAG	804-693-6694	john_mccloskey@fws.gov	Ecological support from EPA
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Peter Knight	ETSG	BTAG	215-814-3321	Peter.knight@noaa.gov	EPA ecological technical support
Donna Caldwell	Technical Support	NAVFAC	757-322-4816	Donna.caldwell@navy.mil	Navy technical support

Comments/Decisions:

The February 2012 Partnering Team meeting was held on February 22 and 23, 2012. Following the January 5, 2012 conference call, RTCs were submitted February 9, 2012 to the Team, and the EPA was still evaluating and drafting comments. At the start of the meeting the process for submitting comments to VDEQ was clarified. The overall purpose of the discussion was to look over the major comments and concerns from EPA/BTAG.

The Team then began to discuss specific comments. The first comment discussed was a concern about the approach to collect surface water, sediment, pore water, and seep samples. In the draft SAP, these samples were dependent on the outcome of the first round of groundwater samples. It was brought up that in the original RI there were samples from Felgates Creek and on a Site walk in Summer 2011, there were a number of discharges/seep locations from the hillside leading to the wetland area. It was argued that this was a potential contaminant transport via the drainage outfalls, and that correct timing of the seep/sediment sampling would be needed at the same time to determine what has been released historically. It was determined that the SAP needed to be revised to indicate that surface water and sediment sampling would no longer be conditional, and would be collected regardless of the outcome of the soil and groundwater samples. These samples will be collected from downstream of the pipes near a depositional area. The seep samples however, would still be collected based on the soil and groundwater results. It was proposed that pipes/drainages and outfalls be included in the SAP, and to include a sediment and surface water sampling map.

Another major concern discussed was that the information presented in the SAP was not sufficient for determining sample locations, that additional information needed to be placed in the text, and that the number of samples was not adequate. In order to appropriately evaluate the site, it was determined that a review of all of the historical documents needed to be performed in support of the proposed sample locations, and all of the historical documents would be posted for review.

Additional comments were discussed and the following actions were agreed upon:

- Need to specifically document in the SAP the reasoning for not looking at PAHs
- The document decision making process needs to be clarified
- Cleanup goals from the ROD need to be included in a future UFP-SAP
- Need more sampling in the excavated area to access risk

May 2012 - Project Scoping Session Participants Sheet

Project Name: Yorktown Site 7 ERI **Projected Date(s) of Sampling:** Fall 2012 **PM:** Adam Forshey	**Site Name:** Site 7 **Site Location:** WPNSTA Yorktown, Virginia
Date of Session: May 30 and 31, 2012 **Scoping Session Purpose:** To discuss response to comments and discuss the sampling approach and sample locations	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Bill Friedmann	AM	CH2M HILL	757-671-6223	william.friedmann@ch2m.com	Overseeing project delivery, technical support
Adam Forshey	PM	CH2M HILL	757-671-6267	adam.forshey@ch2m.com	UFP-SAP production, project management
Moshood Oduwole	RPM	USEPA	215-814-3357	Moshood.Oduwole@epamail.epa.gov	Lead representative of USEPA, responsible for review of documents and ensure that appropriate regulations are applied
Wade Smith	RPM	VDEQ	804-698-4125	wade.smith@deq.virginia.gov	Lead representative of VDEQ, responsible for review of documents and ensure that appropriate regulations are applied
Jim Gravette	RPM	NAVFAC Mid-Atlantic	757-341-0479	Jim.Gravette@navy.mil	Representative of lead agency responsible for overseeing execution of projects

Comments/Decisions:

The May 2012 Partnering Team meeting was held on May 30 and 31, 2012. The meeting started with a quick review of technical support background and information for Site 7, followed by showing the most recent sampling approach proposal.

Then the Team began to discuss the current proposed sample locations and where additional samples may be warranted. Throughout the discussion of all of the different buildings formerly located within Site 7, it was proposed that samples would be collected within former building footprints, in likely loading/unloading areas, and along the former conveyor areas. In addition, the sediment samples collected from outfall locations will be collected from the first depositional area, not from right at the outfall where the scour zone is located. As a follow up action, it was agreed that CH2M HILL would look into the building drawings and historical documents to determine the source of the discharge line from Building 375.

Appendix D
Navy CLEAN Data Management Plan

Version 1

Navy CLEAN
Data Management Plan

Prepared for

Navy CLEAN & Joint Venture Programs

July 2010

CH2MHILL

Preface

This document presents the standardized six-step workflow process for environmental data management being performed for the Navy Comprehensive Long-Term Environmental Action - Navy (CLEAN) and Joint Venture Programs. Included in Appendix A is the responsible, approve, support, consult, and inform (RASCI) diagram along with the associated roles and responsibilities, which is the basis for the Navy CLEAN and Joint Venture Programs Data Management Plan (DMP). Following are the six steps in the workflow process:

1. Project planning and database setup
2. Sample collection and management
3. Laboratory analysis
4. Data validation and loading
5. Data management
6. Data evaluation and reporting

Figure P-1 presents a simplified presentation of the workflow process specific to the Navy CLEAN and Joint Venture Programs.

Figure P-2 presents, in more detail, the tools used in each step of the process. CH2M HILL uses the Sample Tracking Sheet (STS) to initiate the sample collection, documentation, and tracking processes. All field-related data is captured in the Field Data Entry Tool (FDETool). During the laboratory analysis and data validation phase, the SNEDD-QC-Tool software will be used to help evaluate the quality of the data. At the data management step, the SVMTool will be used to format the data and the CH-IMPTool will be used to transfer the data into the Navy CLEAN data warehouse. At the data evaluation stage, the XTabReports Tool will be used to query data from the data warehouse, and the Crosstab Cleanup Tool (CCTool) and the Raw, Detects, and Exceedance (RDE) Formatting Tool will produce and format data tables and comparisons to project action levels. Appropriate section(s) of the DMP include additional details on each of the tools used.

Change Management

This DMP is a "living" document and content may be revised or amended to accommodate changes in the scope of environmental investigations or data management requirements that affect the entire Navy CLEAN and Joint Venture Programs. In addition, the DMP appendices will be subject to modification as new or improved methods of data management are developed and implemented.

Any modifications made to the tools will be communicated to the project team via e-mail. As revisions are finalized, they will be distributed electronically to all users. After revision, it is the user's responsibility to conform to revised portions of the DMP.

Amendments will be versioned and released according to the following naming scheme: [Document Name_v#.#_yymmdd]. If a significant change is made to any of these files, the version number will increase by one integer. The revision history is shown in the following table.

REVISION HISTORY

Navy CLEAN and Joint Venture Programs Data Management Plan

Revision Date	Initiator	Purpose

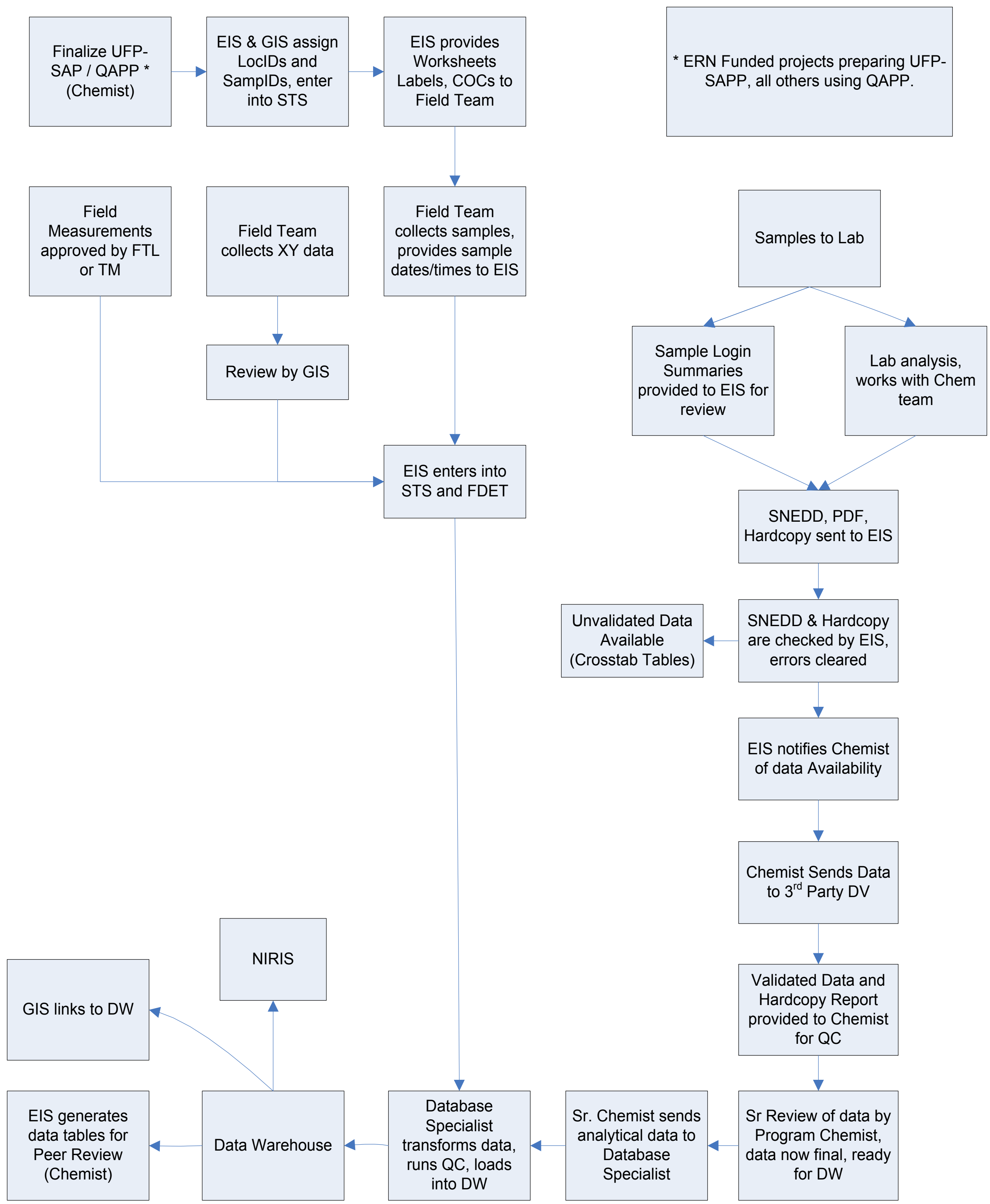

FIGURE P-1
ENVIRONMENTAL DATA MANAGEMENT WORKFLOW PROCESS

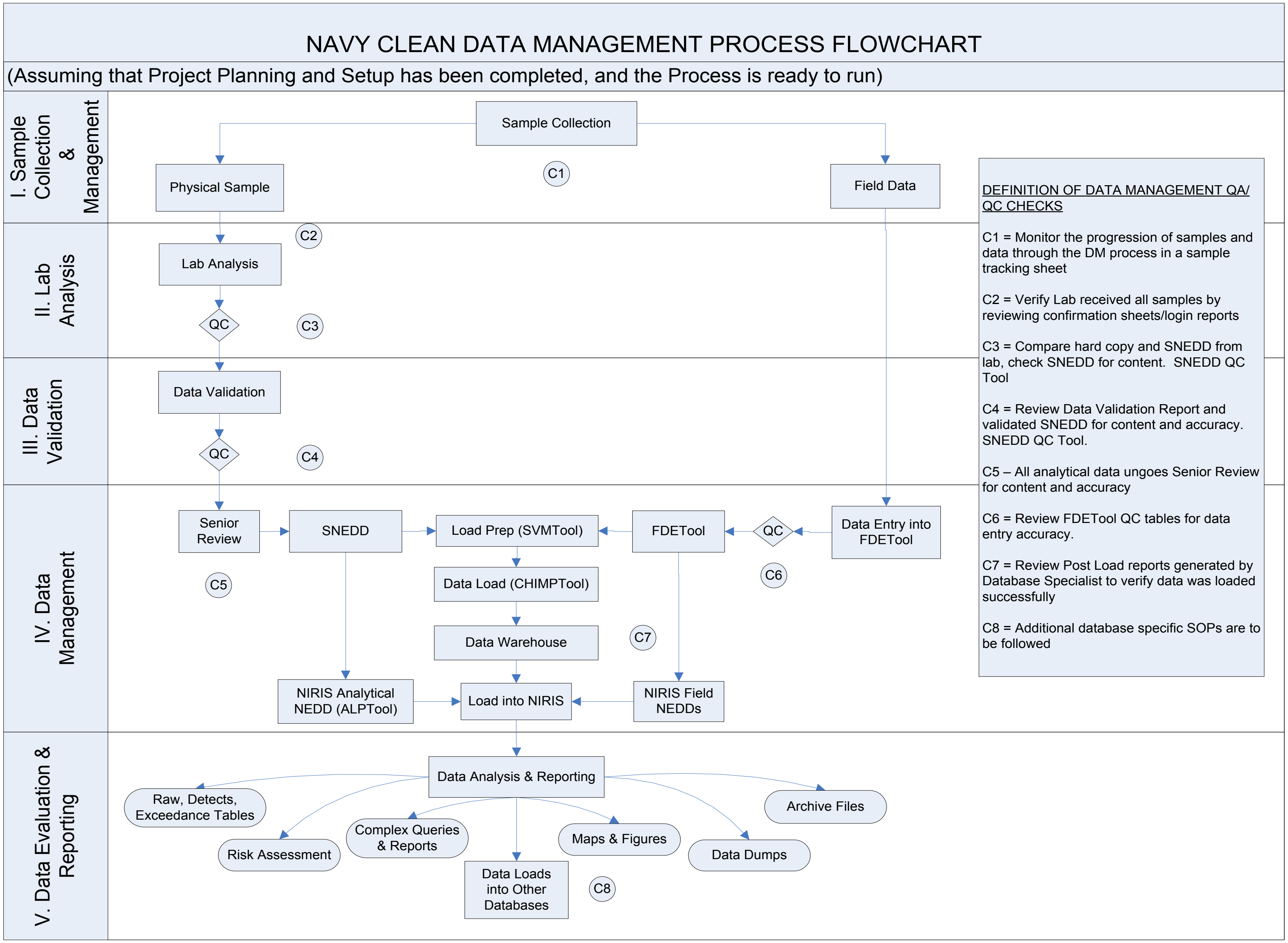

FIGURE P-2
DBMS PROCESS

Contents

Appendices

Tables

Figures

Acronyms and Abbreviations

AFCEE	Air Force Center for Engineering and the Environment
ALPTool	Archive Load and Prep Tool
AM	Activity Manager
CAD	computer-aided design
COC	chain-of-custody
DBMS	Database Management System
DBS	Database Specialist
DMP	Data Management Plan
EDD	electronic data deliverable
EDM	Environmental Data Management
EIS	Environmental Information Specialist
EMS	Enterprise Management Solutions
ERP	Environmental Restoration Program
ERPIMS	Environmental Restoration Program Information Management System
EVS	Environmental Visualization System
FD	Field Duplicate
FDETool	Field Data Entry Tool
FTL	Field Team Leader
GA	GIS Analyst
GIS	geographic information system
ID	identification
IDW	investigation-derived waste
IRP	Installation Restoration Program
MS	matrix spike
MSD	matrix spike duplicate
N/FD	normal/field duplicate
NAVFAC	Naval Facilities Engineering Command
NEDD	NIRIS Electronic Data Deliverable
NIRIS	Naval Installation Restoration Information Solution
ODBC	open database connectivity
PC	Project Chemist
PCL	Program Chemistry Lead
PDL	Program Data Management Lead
PGL	Program GIS Lead
PM	Project Manager

QA	quality assurance
QC	quality control
RASCI	responsible, approve, support, consult, and inform
RDM	Regional Database Manager
SDG	Sample Delivery Group
SIMS	Site Information Management System
SNEDD	Supplemental NIRIS Electronic Data Deliverable
SOP	standard operating procedure
STS	Sample Tracking Sheet
SVMTool	SNEDD to VDMS Mapping Tool
VDMS	Validated Data Management System

SECTION 1
Introduction

This Data Management Plan (DMP) describes the methods CH2M HILL will use to manage and present environmental data to support work it is conducting for the Navy CLEAN and Joint Venture Programs. These processes and procedures are part of an overall environmental data management system called the SNEDD Approach to the Validation Data Management System (VDMS), hosted by CH2M HILL.

Project members and any subcontractors supporting program data needs for site characterization and remediation activities can use this DMP. It is a living document that is flexible enough to meet the dynamic needs of the teams and stakeholders. Data management program details and procedures are included in the appendices.

1.1 Purpose

This document outlines how environmental data for the Navy CLEAN and Joint Venture Programs will be obtained and managed using an Enterprise Management Solutions (EMS) approach. The systematic approach will facilitate the retrieval of data from project files and the data warehouse when they are needed, help ensure that the required data are collected and are of the appropriate quality, and help ensure that data records are not lost during transfer to the central program database repository.

1.2 Scope of the Data Management Plan

The scope of the data management activities addressed by this plan includes the following:

- **Roles.** Definition of staff roles and responsibilities.
- **Project Planning and Setup.** Use standard templates and database applications; provide guidance and standard operating procedures (SOPs) for formatting, reviewing, and transferring data collected in the field to the Database Management System (DBMS).
    - **Provide a structured, yet flexible data set.** The DBMS will store all types of environmental data and provides a standard framework for all projects within the Navy CLEAN Program to use. The DBMS is organized and structured, yet flexible enough to allow additional data and data types to be added at any time over the life of the program.
    - **Provide data that are well documented.** The DBMS will retain enough descriptive and source information for technical defensibility and legal admissibility of the data.
- **Sample Collection and Management.** Items that will be captured through standardized forms or applications include chains-of-custody (COCs), field parameter information, groundwater elevation data, and sample tracking records.
- **Laboratory Analysis.** Laboratory data will be reported in the Supplemental Naval Installation Restoration Information Solution (NIRIS) Electronic Data Deliverable (SNEDD)

format specifications that analytical laboratories are required to use to transfer analytical data electronically to CH2M HILL. (Provided to laboratories via a scope of work.) Management and archive procedures will be implemented for hard copy and electronic project documentation.

- **Data Validation.** Internal and external data validation will be conducted in accordance with the appropriate Program and EPA requirements. All deliverables will be subjected to Senior Review quality assurance (QA) and quality control (QC) measures. Management and archive procedures will be implemented for hard copy and electronic project documentation.
- **Data Management.** QA and QC measures will be implemented to provide accurate representation of all data collected and to be stored in the DBMS. QA/QC procedures include restricting data import or entry to specific valid value lists that will not allow incorrect data to be included in the DBMS.
- **Data Evaluation and Reporting.** Reporting and delivery support will be provided from a single DBMS source and allow relatively simple and rapid access to stored data for environmental characterization, report generation, modeling, geographic information system (GIS) mapping, statistical analyses, and risk assessments.
    - **Provide data visualization capabilities.** Data will be accurately represented for use in models, GIS, boring log programs (Environmental Visualization System [EVS), computer-aided design (CAD), graphics, and other software used for mapping, graphing, charting, analyzing, and displaying environmental data.
    - **Provide the ability to compare data electronically.** Tools will allow the electronic comparison of project data to specific reference or screening criteria.
    - **Provide the ability to transfer data to different formats.** The DBMS will provide the ability to reformat, convert, and transfer the data to any format as required by specific end-user applications.

SECTION 2

Roles and Responsibilities

The Navy CLEAN and Joint Venture Programs Environmental Data Management (EDM) team will work together to properly execute the DMP and ensure that the project objectives and scope are realized. The EDM team is composed of data management, chemistry, and GIS resources. The EDM team is responsible for all aspects of planning, execution, management and reporting environmental of data. Data are derived from sampling events related to investigative and remedial activities for Navy CLEAN and Joint Venture projects.

Responsibilities related to data management and information solutions functions are grouped into roles, as listed in Table 1. The SNEDD DM Process Checklist referenced in Appendix C documents the specific responsibilities associated with each of these roles.

TABLE 1
Navy CLEAN and Joint Venture Environmental Data Management Program Team
The Navy CLEAN Program Data Management Plan

Title	Name/Address	Phone	Fax	E-mail
Navy CLEAN Activity Manager (AM)	Various	Various	Various	Various
Navy CLEAN Project Manager (PM)	Various	Various	Various	Various
Field Team Leader (FTL)	Various	Various	Various	Various
Program Critigen Team Lead	Mike Dierstein 5700 Cleveland Street Suite 101 Virginia Beach, VA 23462	757-671-6216	757-497-6885	mdierste@critigen.com
Program Data Management Lead (PDL)	Chelsea Leigh 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6208	773-695-1378	cleigh@critigen.com
Database Specialist (DBS)	Bhavana Reddy 15010 Conference Center Dr. Suite 200 Chantilly, VA 20151	703- 462-3784	703- 376-5010	breddy@critigen.com
Program Chemistry Lead (PCL)	Anita Dodson 5700 Cleveland Street Suite 101 Virginia Beach, VA 23462	757-671-6218	757-497-6885	adodson@ch2m.com
Project Chemist (PC)	Mike Zamboni 15010 Conference Center Dr. Suite 200 Chantilly, VA 20151	703-376-5111	703-376-5801	mzamboni@ch2m.com
Project Chemist (PC)	Megan Morrison 15010 Conference Center Dr. Suite 200 Chantilly, VA 20151	703-376-5053	703-376-5801	megan.morrison@ch2m.com

TABLE 1
Navy CLEAN and Joint Venture Environmental Data Management Program Team
The Navy CLEAN Program Data Management Plan

Title	Name/Address	Phone	Fax	E-mail
Project Chemist (PC)	Bianca Kleist 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6281	757-497-6885	bkleist@ch2m.com
Project Chemist (PC)	Juan Acaron 3011 S.W. Williston Road. Gainesville, FL 32608	352-384-7002-		juan.acaron@ch2m.com
Project Chemist (PC)	Kristina Lambert 3011 S.W. Williston Road. Gainesville, FL 32608	352-335-5877		kristina.lambert@ch2m.com
Environmental Information Specialist (EIS)	Genevieve Moore 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6284	757-497-6885	gmoore@ch2m.com
Environmental Information Specialist (EIS)	Rebekha Shaw 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6279	757-497-6885	rshaw22@ch2m.com
Environmental Information Specialist (EIS)	Gwendolyn Buckley 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-8311	757-497-6885	Gbuckle1@ch2m.com
Environmental Information Specialist (EIS)	Victoria Brynildsen 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6252	757-497-6885	vbrynildsen@ch2m.com
Program GIS Lead (PGL)	Mike Dierstein 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6216	757-497-6885	mdierstein@critigen.com

TABLE 1
Navy CLEAN and Joint Venture Environmental Data Management Program Team
The Navy CLEAN Program Data Management Plan

Title	Name/Address	Phone	Fax	E-mail
GIS Analyst (GA)	Blake Hathaway 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6230	757-497-6885	bhathawa@critigen.com
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GIS Analyst (GA)	Mark Unwin 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6261	757-497-6885	munwin@critigen.com
GIS Analyst (GA)	Chris Bowman 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6276	757-497-6885	cbowman@critigen.com
GIS Analyst (GA)	Matt Rissing 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6243	757-497-6885	mrissing@critigen.com
GIS Analyst (GA)	Forrest Cain 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6271	757-497-6885	fcain@critigen.com

SECTION 3

Data Management System Description

During field investigation, monitoring, and remedial activities, CH2M HILL will collect a variety of environmental information to support data analysis, reporting, and decision-making activities. To meet current regulatory QA requirements, a complete audit trail of the information flow must be implemented. The six steps in the workflow process are (Appendix B):

1. Project planning and database setup
2. Sample collection and management
3. Laboratory analysis
4. Data validation
5. Data management and loading
6. Data evaluation and reporting

Each step in the data management process must be adequately planned, executed, and documented. Figure 1 presents a simplified presentation of the workflow process specific to the Navy CLEAN and Joint Venture Programs. Figure 2 presents, in more detail, the tools used in each step of the process.

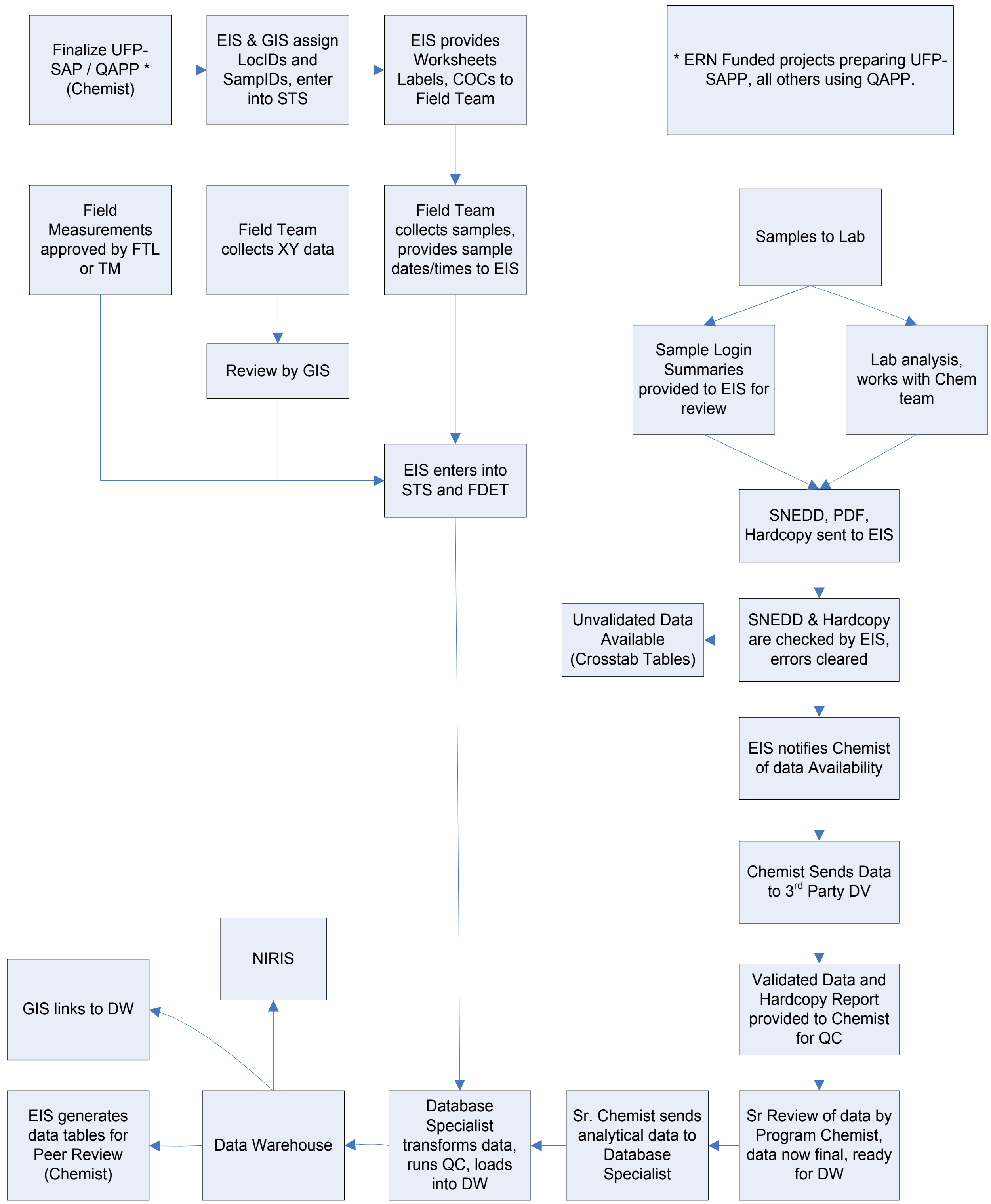


FIGURE 1
ENVIRONMENTAL DATA MANAGEMENT WORKFLOW PROCESS

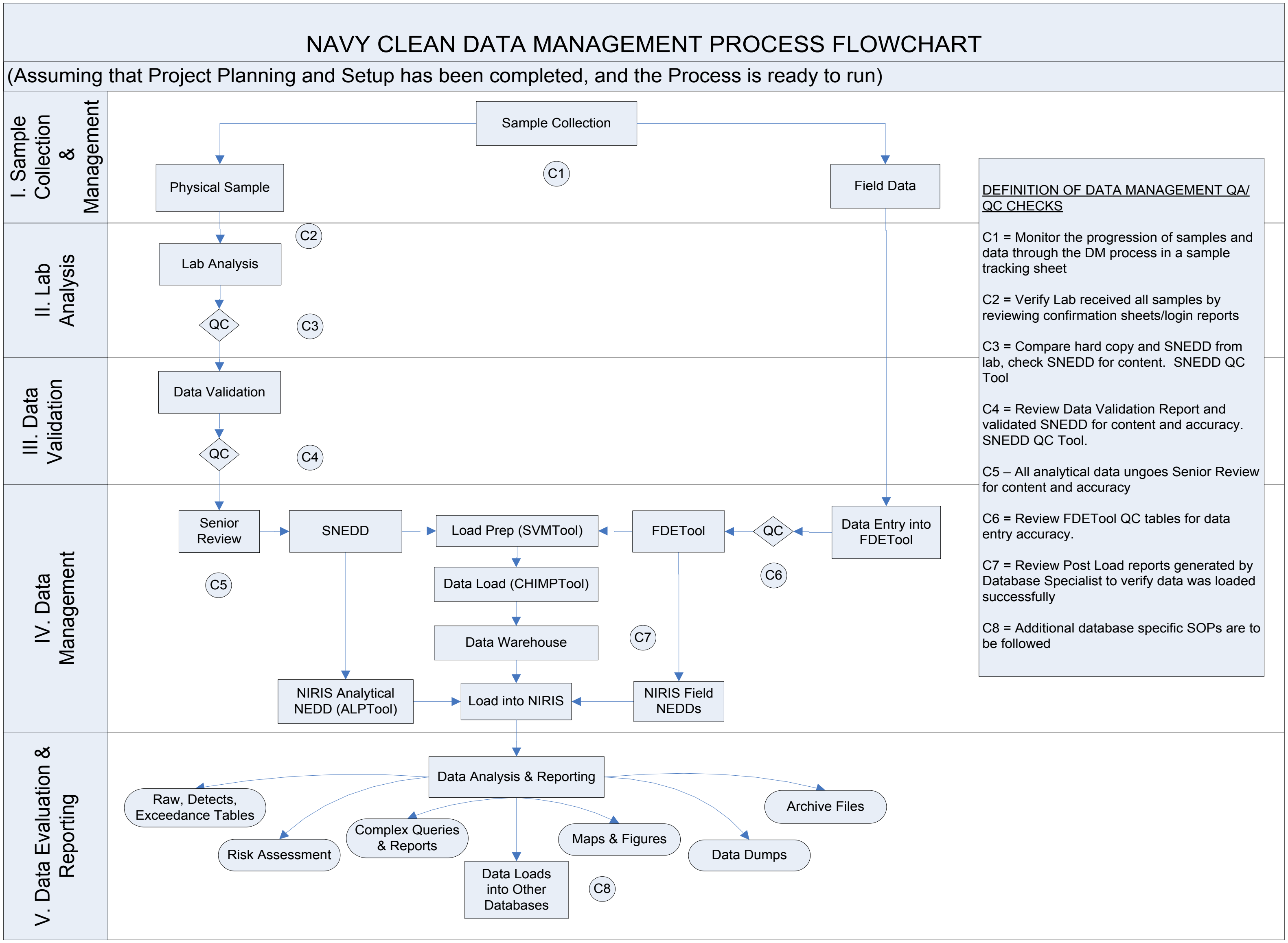


FIGURE 2
DBMS PROCESS

SECTION 4

Phases of Data Management

4.1 Project Planning and Setup

Project planning starts when a new project or task is identified in the program. Evaluation of what is required from data management and visualization occurs to determine the data needs. The Program Critigen Team Lead (Critigen Lead) works with the Program Data Management Lead (PDL) and the project and/or activity manager to determine what is expected and required from the data management and visualization team. Specific items that should be considered are as follows:

- Inputs – Determine what data will be collected and stored in the database. Determine frequency and quantity. Determine what tools will be used to handle data input.
- Historical Data – This is a unique data input and requires special consideration. The PDL ***must*** work with the other technical leads to assess what effort will be required. This step is often missed, and the resulting data quality issues created from inadequate planning in this area can plague the project for its entire duration.
- Outputs – Determine what data will need to be presented in reports, figures, and electronic deliverables. Determine frequency and quality requirements. Determine preliminary data, validated data, and what tools will most effectively handle the output requirements. Discuss how the outputs needed by the team will be requested and documented.
- Visualization – Determine necessity for GIS and CAD.

After the information above is determined, the data management scope, schedule, and budget are developed and endorsed by the Project Manager (PM), PDL, Program GIS Lead (PGL) and Program Chemistry Lead (PCL). The team can then proceed upon client authorization of the overall project budget. Figure 3 shows the process for project planning.

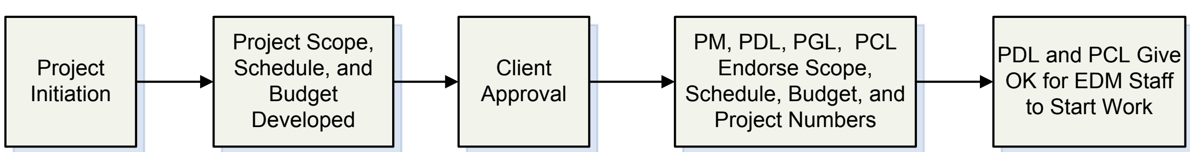


FIGURE 3
PROJECT PLANNING

4.1.1 Database Setup and Administration

CH2M HILL Database

The PDL will oversee the administration of the DBMS, including the design, development, and maintenance of the program database, tools and data management processes. Database and data management process design and development will focus on providing rapid data entry and data retrieval while promoting data integrity through various automated procedures. The PDL will perform the database maintenance, which consists of the following:

- Assisting with the allocation of sufficient system storage for the program database
- Adding, altering, and deleting users, roles, and privileges
- Periodically defragmenting and compacting the database for more efficient operation
- Upgrading database software and associated applications as necessary
- Maintaining an approved list of valid values for data consistency
- Maintaining redundancy control to ensure that each data record is unique and consistent with conventions
- Performing routine virus checks on incoming and outgoing data

The DBMS is comprised of the Data Warehouse and associated SNEDD-Approach tools, and will support the storage, analysis, display, and reporting of the Navy's environmental, analytical, and geotechnical data. The DBMS will consist of primary data tables that store the environmental data, dependent tables that store more details related to the data in the primary tables, and look-up tables that store valid values to provide input to the primary tables. The EIS will maintain the table content and the PDL will manage it.

Valid values are critical to any large relational database. Tables 2 and 3 provide examples of valid values for the Navy CLEAN and Joint Venture Programs' sites, stations, and samples. Inconsistencies in naming conventions, subtle analyte or method spelling differences, and the use of non-standard abbreviations can result in lost data and incorrect conclusions. Most tables and forms in the program database will use look-up tables for acceptable valid values and will not allow the entry of data that do not conform.

The primary purpose of managing data in a relational database environment is to ensure that each data record is unique and that the information contained within each field is consistent with conventions defined in other areas of the database. To ensure that each record is unique, a key field or fields will be identified within each data table. The VDMS Data Warehouse architecture supports this approach and eliminates the possibility of data redundancy.

NIRIS Database

All Navy CLEAN and Joint Venture data must be loaded into the Navy's own internal database system, the Naval Installation Restoration Information Solution (NIRIS). NIRIS is a web-based centralized database that has been implemented across all Naval Facilities Engineering Command (NAVFAC) offices and will be used by the Navy and contractors to manage, evaluate, and visualize data, documents and records for Navy and the Marine Corps sites. NIRIS manages all Environmental Restoration Program (ERP) analytical and spatial data, which includes the Munitions Response and Installation Restoration Program (IRP) data, ensuring institutional memory is preserved, land use controls are maintained, and remedial actions are effective.

CH2M HILL will use the SNEDD Approach to VDMS system to track, collect, review, and prepare Navy-related sample and project data for loading into NIRIS. Project data stored in the

VDMS Data Warehouse must be consistent and comparable with data that is loaded and stored within NIRIS. As such, all associations between VDMS and NIRIS valid values, output reports, and data tables will be tracked and maintained.

4.1.2 Data Security Procedures

Some SNEDD Approach to VDMS applications and data are stored in a secure location with login and password protection. Authorized users will have logins and passwords in advance. The PDL will provide security access to these tools. Access2003 must be installed on the computer that the user will be using to run these applications, and proper licenses distributed. Files received from any subcontractors will be scanned for common viruses using industry standard, current virus protection programs. The file servers storing the data must be running current virus software, with automatic virus signature updates.

NIRIS data are stored in a secure location with login and password protection. Users who require access to NIRIS and the data contained therein will need to follow procedures outlined in the SOP Access to NIRIS to procure security certificates, training, and access rights to installation-specific data. Authorized users of NIRIS will be assigned logins and passwords maintained by the Navy. For further information on NIRIS or obtaining NIRIS access, consult with the Critigen Lead or PDL.

4.1.3 Data Backup and Recovery

All project data management files will reside on CH2M HILL's terminal server, "Gaia," and will have a tape backup or equivalent created in accordance with CH2M HILL's network server management policy.

4.2 Sample Collection and Management

Sample control during the sampling phase is required to ensure the integrity of the associated data. Sample control must be maintained and documented from the point of collection through the point of disposal. Sample control will be managed both in the field and in the laboratory, and will be documented using field logbooks and a Chain of Custody (COC). When custody of a sample is transferred from one party to another, the recipient of the sample assumes responsibility for maintaining control of the sample and documenting that control on the COC. Figure 4 shows the process for planning and executing field sampling events.

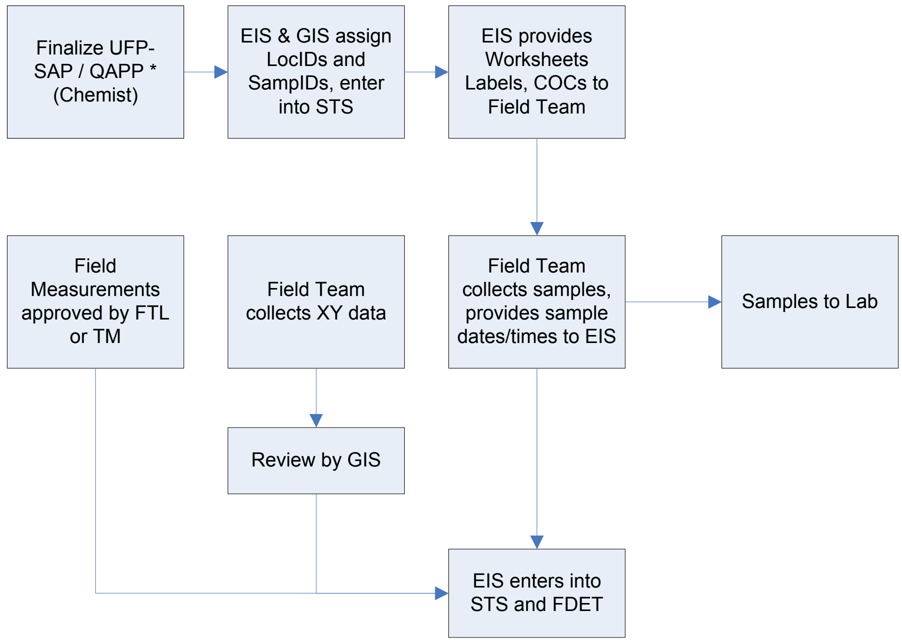


FIGURE 4
FIELD SAMPLING

4.2.1 Sample Tracking Sheet

During the planning stage, the PM specifies the data requirements for the sampling event. The work plan or similar document will provide project-specific data requirements for a given sampling event. The Project Chemist (PC) is responsible for reviewing the Sampling and Analysis Plan and ensuring that the FTL is aware of the number of field and laboratory QC samples required for the sampling event (trip blanks, equipment blanks, field blanks, field duplicates, matrix spikes, and matrix spike duplicates). All of this information is to be entered into the STS.

The STS will be used in advance to identify sampling container and preservation requirements, identify analytical laboratories for samples, aid in the generation of labels for sample bottles before the sampling event, and prepare COC forms after sampling is complete.

4.2.2 Sample Nomenclature Guidelines

The following guidelines are provided for sample nomenclature, COC clarification, and eData expectations.

Station ID (Location)

Field station data are information assigned to a physical location in the field at which some sort of sample is collected. For example, a monitoring well that has been installed will require a name that will uniquely identify it with respect to other monitoring wells or other types of sample locations. The station name provides a key in a database to which any samples collected from that location can be linked to form a relational database structure.

Before beginning fieldwork, the FTL will review the proposed level of effort and coordinate a list of unique station identification names, or station IDs, with the PDL or EIS. The FTL will be responsible for enforcing the use of the standardized ID system and agreed upon station IDs during all field activities.

Each station will be uniquely identified by an alphanumeric code that will describe the station's attributes. These attributes are facility, Area of Concern (AOC)/Site/Operable Unit (OU) number, station type, sequential station number, and possibly an additional qualifier as needed. The naming scheme to be used for the identification of a sampling station is documented in Table 2.

For example, if the first sample location at next month's event within Yorktown Site 30 is at a soil location, then the location ID could possibly be YS30-SO391 because that was the next available sequence number for soil locations. This should also be reflected in the Sample ID. QC and IDW station IDs must be established for each site that they are associated with.

Please consult with the PDL or EIS should any questions arise. This will avoid complications that could occur if a station is mislabelled and ensure there are unique identifiers for every sampling location. Required deviations to this format in response to field conditions will be documented in the field logbook.

Sample ID

Field sample data are information assigned to a physical piece of material collected in the field for which some sort of analysis will be run. Before collecting samples, the FTL will review the proposed level of effort and coordinate a list of unique sample identification names, or sample IDs, with the PDL or EIS. The FTL will be responsible for enforcing the use of the standardized ID system and agreed upon sample IDs during all field activities.

Each sample will be uniquely identified by an alphanumeric code that will describe the sample's attributes. These attributes are facility, Area of Concern (AOC)/Site/Operable Unit (OU) number, sample/station type, sequential station number, modifier (as needed), depth (as needed), date, and date modifier (as needed). The naming scheme to be used for the identification of samples is documented in Table 3.

The standardized ID system will identify all samples collected during sampling activities. The system will provide a tracking procedure to ensure accurate data retrieval of all samples taken. For example, a surface soil sample collected from station YS30-SO391 reference above in June of 2009 will result in a sample ID of YS30-SS391-0609.

Please consult with the PDL or EIS should any questions arise. This will avoid complications that could occur if a sample is mislabelled and ensure there are unique identifiers for every sample. Required deviations to this format in response to field conditions will be documented in the field logbook.

Navy Clean

First Segment	Second Segment	
Facility, Site Number	Station Type	Station Number, Modifier
AA,ANN	AA	NNN$_A$

Notes: "A"= alphabetic "N"= numeric

Facility:

A = ABL
AN = Anacostia
BA = Bainbridge
BW = Bloodsworth Island
BR = Bremerton
CA = Cheatham Annex
CH = Cherry Point
CI = Craney Island
CL = Camp Lejeune
CP = Camp Peary
CR = Carderock
DA = Dahlgren
DN = Dam Neck
DR = Driver
IH = Indian Head
LS = Little Creek
NA = Naval Academy
NB = Naval Station Norfolk
NM = NNMC (Bethesda Naval Hospital)
NN = Norfolk Naval Shipyard
NR = Naval Research Laboratory
NWA = Northwest Annex
OC = Oceana
PA = Pax River
PI = Pineros Islands
QU = Quantico
RO = Rota
RR = Roosevelt Roads
SI = Sigonella
SJ = St. Juliens
SS = Sabana Seca
VE = Vieques East
VW = Vieques West
WN = Washington Navy Yard
WO = White Oak
Y = Yorktown

Site/AOC/SWMU Number – Sequential Number:

Site = S01, S02, S03…
Site Screening Area = SA01, SA02, SA03…
AOC = A01, A02, A03…
AOI = AI01, AI02, AI03…
SWMU = W01, W02…
Building = B01, B02, B03…
Range = R01, R02…
LIA – LI Area, East Vieques

BSxx = Background locations outside of site (BS25 = Background Site 25)
BKL = Background locations outside of the facility
BKG = Background locations (inside base)

QC and IDW Stations
Site ID (First Segment) followed by –QC or -IDW

Station Type:

AGT = Above Ground Tank
AS = Ash
BH = Borehole
CO = Concrete
DP = Direct Push
DR = Drill Rig
EW = Extraction Well
FG = Frog
FS = Fish
GB = Geotechnical Boring
GP = Geoprobe
GV = Gas Vent
HP = Holding Pond/Lagoon
IDW = Investigative Derived Waste
IW = Injection Well
LW = Leach Well
MA = Alluvial Monitoring Well
MB = Bedrock Monitoring Well
MU = UST Monitoring Well
MW = Monitoring Well (GW for Y)
PC = Paint Chip
PW = Production Well
QC = Quality Control
RK = Rock
RC = Recovery Well
RM = Remediation Well
RW = Residential Well
SD = Sediment Location
SG = Soil Gas
SL = Storm Sewer Line Sediment
SO = Soil Location
SP = Seep
ST = Storm Water
SU = Sump
SV = Soil Vapor
SW = Surface Water
SWS = Surface Water Body (for SW and SD)
UST = Underground Storage Tank
TA = Tap Water
TD = Tidal Station
TI = Tissue Sample (general)
TO = Tadpole
TP = Test Pit
TR = Trench Sediment
TS = Treatment System
TW = Temporary Well
WA = Alluvial Extraction Well
WB = Bedrock Extraction Well
WL = Water Supply Well
WN = Pore Water
WP = Wipe Sample
WT = Water Table Piezometer

Station Number:
Sequential Station Number (i.e., 01, 02, 03…)

Modifier (used selectively):
D = Deep monitoring well
S = Shallow monitoring well

Example Station IDs:

YS01-DP02 = Direct push soil location #2 at Yorktown Naval Weapons Station Site 1
CHR05-MW02S = Shallow monitoring well location 2, at the Cheatham Annex facility, Range 5.
NMBKL-SD02 = Background sediment location #2 located outside of NNMC
CHBS03-SO05 = Soil location #5, located in reference area outside of Site 3 in Cherry Point
VEW04-QC = QC Station at East Vieques SWMU-4
CAA08-IDW = IDW Station at Cheatham Annex AOC-8

TABLE 2

STATION ID SCHEME

Navy Clean			
First Segment	**Second Segment**	**3rd Segment**	**Fourth Segment**
Site ID Facility, AOC Number	Station/Sample Type, Station Number, Modifier	Depth (As Needed)	Date (MMYY) $_A$
AA,ANN	AANNN$_A$	A	NNNN$_A$
Notes: "A"= alphabetic "N"= numeric			
A = ABL AN = Anacostia BA = Bainbridge BW = Bloodsworth Island BR = Bremerton CA = Cheatham Annex CH = Cherry Point CI = Craney Island CL = Camp Lejeune CP = Camp Peary CR = Carderock DA = Dahlgren DN = Dam Neck DR = Driver IH = Indian Head LS = Little Creek NA = Naval Academy NB = Naval Station Norfolk NM = NNMC (Bethesda Naval Hospital) NN = Norfolk Naval Shipyard NR = Naval Research Laboratory NWA = Northwest Annex OC = Oceana PA = Pax River PI = Pineros Islands QU = Quantico RO = Rota RR = Roosevelt Roads SI = Sigonella SJ = St. Juliens SS = Sabana Seca VE = Vieques East VW = Vieques West WN = Washington Navy Yard WO = White Oak Y = Yorktown <u>Site/AOC/SWMU – Sequential Number:</u> Site = S01, S02, S03… Site Screening Area = SA01, SA02, SA03… AOC = A01, A02, A03… AOI = AI01, AI02, AI03… SWMU = W01, W02… Building = B01, B02, B03… Range = R01, R02… LIA – LI Area, East Vieques BSxx = Background locations outside of site (BS25 = Background Site 25) BKL = Background locations outside of the facility BKG Background locations (inside base)	<u>Sample Type:</u> AGT = Above Ground Tank AH = Air - Headspace AS = Ash BH = Borehole CO = Concrete DR = Drill Rig DS = Direct Push—Soil DW = Direct Push—Groundwater EW = Extraction Well FG = Frog FS = Fish GB = Geotechnical Boring GP = Geoprobe GV = Gas Vent HP = Holding Pond/Lagoon IW = Injection Well LF = Free Product LW = Leach Well MA = Alluvial Monitoring Well MB = Bedrock Monitoring Well MU = UST Monitoring Well MW = Monitoring Well (GW for Y) PC = Paint Chip PW = Production Well RK = Rock SW = Surface Water RC = Recovery Well RM = Remediation Well RW = Residential Well SB = Subsurface Soil SD = Sediment Location SG = Soil Gas SL = Storm Sewer Line Sediment SO = Soil Location (Composite) SP = Seep SS = Surface Soil SSD = Subsurface Sediment ST = Storm Water SU = Sump SV = Soil Vapor SW = Surface Water UST = Underground Storage Tank TA = Tap Water TD = Tidal Station TI = Tissue Sample (general) TO = Tadpole TP = Test Pit TR = Trench Sediment TS = Treatment System TW = Temporary Well WA = Alluvial Extraction Well WB = Bedrock Extraction Well WL = Water Supply Well WN = Pore Water WP = Wipe Sample WT = Water Table Piezometer <u>Station Number:</u> Sequential Number (e.g., 001, 002, 003) <u>Modifier (used selectively):</u> D = Deep monitoring well S = Shallow monitoring well P = Duplicate	<u>Depth</u>: Use only if applicable. A sequential letter is used to reflect varying depths, as actual depths can change in the field after sample planning has occurred. E.g. A, B, C… <u>Sample Number:</u> 1. Duplicate Samples - Use a 'P' modifier in the second segment of the sample ID, directly after the location number to indicate a duplicate sample. E.g. AB01-MW11P-0506 2. MS/MSD Samples – Append a modifier of '-MS' for matrix spike or '-SD' for matrix spike duplicate to the end of the sample ID. 3. QC & IDW Samples (Blank Samples & Waste Char.) - Format consists of Facility, AOC Number, Qualifier Code, Sequential Qualifier Number-Date (AAANN-AANN-MMDDYY). E.g. LSA05-TB02-061106 <u>Qualifier Codes</u>: TB = Trip Blank FB = Field Blank EB = Equipment Blank WQ = Source Blank WS = Waste Char. Soil WW = Waste Char. Water 4. Drill Rig Samples – Format consists of Facility, AOC Number, Station Type, Station Number, Date. E.g. YS12-DR02-020507 5. Multiple samples - Should multiple samples be collected from the same location in a given day/month (affects only samples not differentiated by depth), a sequential letter will be added to the end of the fourth segment (date). E.g. A, B, C…	
<u>Example Sample IDs:</u> <u>WNA01-MW102S-0105A</u> = The first shallow groundwater sample collected at monitoring well location 102 in January 2005 in AOC01 at the Washington Navy Yard facility. <u>PIW01-SW023P-0306</u> = Pineros Island duplicate surface water sample collected at location 23, at SMWU-1 in March 2006. <u>SSW06-FB01-061106</u> = The first field blank collected on June 11, 2006 at SMWU-6 in Sabana Seca.			

TABLE 3

STATION ID SCHEME

4.2.3 Sample Collection

A photocopy of each field logbook page completed during sampling and of each COC will be made by the FTL and forwarded to the EIS at predefined intervals during sampling events. This information will serve as notification to the EIS of samples being shipped to an offsite lab and of the field crew's sampling progress.

Communication with field and laboratory staff will occur daily during the field event. The EIS will resolve issues that arise in the field (i.e. bottle ware shortage, equipment failure, etc). The lab will be informed of the shipment dates and the number of coolers or samples being sent. Laboratory login reports will be reviewed to ensure samples were received in good condition (i.e. no breakage, within holding time, within designated temperature). The field crew and PM will be notified if there were problems with shipment.

4.2.4 Chain-of-Custody

A single COC number per laboratory / cooler should be generated each day (there can be multiple pages to one COC number). MSs and MSDs will be requested at a set frequency for each project (usually one per 20 samples collected). MS and MSD samples should not be taken from field duplicates (FDs) or field blanks. FDs will be requested at a set frequency for each project (usually one per 10 samples). FDs should not be taken from MSs, MSDs, or field blanks. The MS and MSD samples listed on the COC should be spiked and analyzed by the laboratory.

A 100% QC will be performed on COCs received from the field crew. The field crew and/or lab will be notified if corrections need to be made to the COCs or lab login reports. Any corrections or modifications made will be noted in a Corrections-To-File Letter.

4.2.5 Sample and Document Tracking

The STS will be updated with sample collection and tracking information, and kept current throughout the data management process. All samples collected, resulting deliverables, and deliverable dates will be tracked throughout the data management process to ensure that the project schedule is met and subcontractor invoices are evaluated correctly.

All documentation acquired during the data management process, including Statements of Work (SOWs), Bids, COCs, Field Notes, Sample Tracking Sheets, Login Reports, Corrections-to-File Letters, FDETool QC tables, Post Load Reports, Invoices, and Communication Logs shall be compiled throughout the process to be stored in the appropriate Activity's Project Notebook.

4.2.6 Field Data

Once the field data and samples are collected, necessary field measurements, such as water levels and other data collected in the field should be entered into the FDETool. Any data entered into the FDETool must be exported into an excel file to facilitate a manual QC review of the data. The correction of any anomalies should be verified with the PM and PC. The information entered into the FDETool will be linked with related analytical data reported in the SNEDD within the SVMTool. Field data and laboratory analytical data are linked by sample ID and date/time. This allows verification analytical results for all samples have been received and reported by the laboratory.

4.3 Laboratory Analysis

Figure 5 shows the laboratory analysis process. Upon receipt of samples from the field, the laboratory will verify that the COC forms correctly identify and detail all samples submitted. Each COC form must be signed with the date and time of receipt by the laboratory. Samples will be logged in by the laboratory using information from the COC forms and the project instructions.

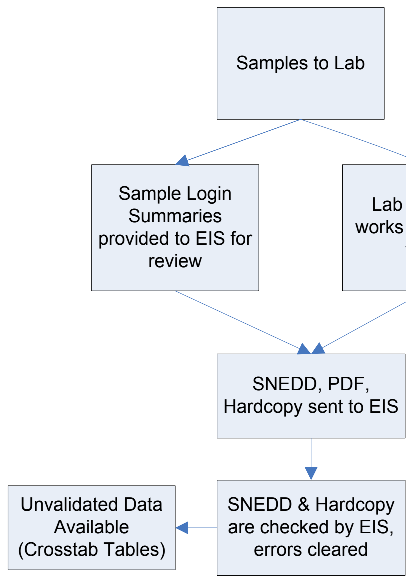


FIGURE 5
LABORATORY ANALYSIS

Samples will be analyzed as specified on the accompanying COC forms and in the Laboratory SOW. Generally, questions or noted inconsistencies identified by the laboratory should be addressed directly to the EIS. Login summaries detailing all samples and analyses received by the lab should be provided daily to the EIS for review. All discrepancies should be corrected to ensure that all samples are analyzed as per project instructions.

The SNEDD-QC-Tool is used to QC the laboratory's SNEDD. Before the laboratory analytical data is formatted into data tables or sent for validation, the laboratory SNEDD must be processed through CH2M Hill's SNEDD-QC-Tool Microsoft Access database application. The SNEDD-QC-Tool includes several automated diagnostic checks to verify format and content compliance with SNEDD specifications.

- The analytical laboratory may, at their discretion, utilize the tool to QC and correct any errors before transmitting the SNEDD to CH2M HILL. The laboratory will forward the checked SNEDD and a hard copy of the data to the EIS, who will manage the SNEDD verification process.

- Upon receipt at CH2M HILL, the EIS will check the SNEDD using the SNEDD-QC-Tool to verify correct format and content. If errors are found, the laboratory will be notified of the errors, and the SNEDD corrected.

The laboratory will attach the signed COCs to their hard copy data deliverables to officially relinquish control of the data back to the Environmental Contractor within the specified turnaround time. Data archiving forms will be generated and affixed to each laboratory report received per Sample Delivery Group (SDG) for cataloguing, tracking, and archiving purposes.

Hard copy data and SNEDDs will be reviewed to ensure that they are complete and acceptable as outlined in the Data QC Checklist. A 10% comparison between the hard copy and SNEDD content will be conducted to ensure consistency, resolve discrepancies, and document data error issues (for example, EDD re-submissions, turnaround time problems, hard copy incompleteness). All detected errors should be resolved with the laboratory.

These checks ensure the consistency and the validity of the SNEDD and hardcopy content before the data are reported in preliminary tables or sent for validation. The objective of using the SNEDD-QC-Tool is to ensure that the validation process is performed on consistently high-quality data and minimize the chance of finding data errors later in the validation process, which would require the laboratory to resend corrected data and start the validation process over again.

Preliminary raw and detects tables will be generated from data reported in the SNEDD by the Navy RD Formatting Tool – Unval/Val SNEDD. A separate table must be created for each matrix, and provided to the PM for review.

4.4 Data Validation

Once the preliminary data verification is complete, the PC is notified by the EIS that the data is available for validation. The PC will notify the data validator in advance of when to expect data and of any samples or analyses that should not be validated (i.e. grain size should not be validated). For internal data validation, the EIS will notify the PC of data availability, and provide the hardcopy data and a QC Association Table.

Upon receipt of data from CH2M HILL, data validation will be performed in accordance with the Data Validation SOW, UFP SAP, and any other documents required. Generally, questions or noted inconsistencies identified by the validator should be addressed directly to laboratory, with the PC notified of issues and resolutions identified.

4.4.1 External Data Validation

For external data validation, a copy of the SNEDD, hard copy data, and a QC Association Table will be provided to the data validator. The PC will coordinate the return of the data package to CH2M HILL for archiving with the data validator.

Data Validators will provide the following materials to the PC within the required turn around time:

- Hardcopy Data Validation Report
- Validated Version of the SNEDD (external validation)

Once returned to CH2M HILL, the SNEDD will be run through the SNEDD-QC-Tool, which includes automated diagnostic checks for validated data to verify format and content compliance with SNEDD validation specifications. The PC will review the validated data to ensure that they are complete and acceptable as outlined in the Data QC Checklist. A 100% QC check will be performed on the validated results to ensure that the hard copy data matches the SNEDD. All detected errors should be resolved with the data validator.

Data archiving forms will be generated and affixed to each Data Validation Report per SDG received for cataloguing, tracking, and archiving purposes.

Validated raw and detects tables will be generated from data reported in the validated SNEDD by the Navy RD Formatting Tool – Unval/Val SNEDD. A separate table must be created for each matrix, and provided to the PM for review.

4.4.2 Internal Data Validation

For internal data validation, a copy of the SNEDD, hard copy data, and a QC Association Table will be provided to the PC.

The PC will evaluate QC information, associated validation logic, and apply qualifiers to data in the SNEDD and on the laboratory Form Is when QC criteria are not achieved. Qualifier criteria will be based on the Quality Assurance Project Plan. A hardcopy data validation report will be generated. Data archiving forms will be generated and affixed to each Data Validation Report per SDG validated for cataloguing, tracking, and archiving purposes

Validated raw and detects tables will be generated from data reported in the validated SNEDD by the Navy RD Formatting Tool – Unval/Val SNEDD. A separate table must be created for each matrix, and provided to the PM for review.

4.4.3 Unvalidated Data Preload Check

Occasionally, unvalidated data will need to be loaded into the database. Although the data will not be validated, it will undergo a basic Preload Check by the PC to ensure laboratory compliance with project guidelines and determine results to be reported as the best result where multiple runs were conducted for a given sample/analysis. The PCL will provide input and oversight to ensure that data flags are applied correctly by the PC.

4.4.4 Senior Review

The PCL will verify that the final SNEDD and hardcopy data are complete and acceptable. Any identified discrepancies will be resolved with the assistance of the PC, EIS, laboratory, or validator as needed.

4.5 Data Preparation and Loading

Once the data are considered final and approved by the PCL, they are exported from the SNEDD to the project Data Warehouse. Field and laboratory data are merged into a format that is amenable to the warehouse. The backbone is a SQL-server-based data warehouse.

4.5.1 Data Preparation

As part of the normal process of loading data into the warehouse, data standardization tasks must be completed. A Database Specialist (DBS) will load data into the warehouse using the following three programs: SNEDD-QC-Tool, SVMTool and CH-IMPTool.

A final QC of the data reported in the SNEDD is conducted with the SNEDD-QC-Tool. Any identified discrepancies will be resolved with the assistance of the PCL, PC, or EIS as needed.

SNEDDs that pass all of the QA/QC checks in the SNEDD-QC-Tool are then processed with the SVMTool.

The SVMTool links the field data contained in the FDETool to the analytical data contained in the SNEDD. A series of logical QC checks are run to ensure that all data links correctly minimum data requirements are met. The tool then merges the data into a format compatible with the data warehouse structure.

4.5.2 Data Loading

CH2M HILL Loading

The CH-IMPTool runs an additional series of QC checks and adds project-specific formatting, and loads the data into the warehouse. The following tasks need to be completed to load the data for project use:

- **Unit Standardization:** Analytical units and the associated results, reporting limits, and method detection limits will need to be converted to a consistent set of units as required by the project.
- **Resolve Reanalysis and Dilutions:** All samples that had an associated reanalysis or dilution run by the laboratory must have all of the excluded or rejected results marked as not the best result for reporting.
- **Resolve Analytical Overlap and Split Samples:** Analytical overlap occurs when a sample is analyzed by two or more methods that report the same analyte. To resolve any issues not previously resolved, the following logic is used to select the usable result:
  - If the overlapping results are all non-detections, the lowest non-detection result is selected.
  - If the overlapping results are all detected, the highest detected result is selected.
  - If the overlapping results consist of a mixture of detections and non-detections, the highest detected result is selected.

When data are loaded into the warehouse, an automated script will run to identify the “best” result when more than one analytical result exists.

NIRIS Loading

All Navy CLEAN and Joint Venture data must be loaded into NIRIS. Following the successful loading of data into the data warehouse, the DBS will use the FDETool and ALPTool to generate project NIRIS Electronic Data Deliverables (NEDD) files. Field-related NEDDs will be generated from the final version of the FDETool. The final version of the project SNEDD will be processed through the ALPTool to generate the analytical NEDD.

The DBS will use NIRIS’s Data Checker Loader Tool to QC and submit the project NEDD files into NIRIS. The NIRIS Regional Database Manager (RDM) will load the data into NIRIS, and will work with the DBS to resolve any potential issue that may arise during loading. Following notification of successful data loading from the RDM, the DBS will query the data from NIRIS for review to ensure data integrity and accuracy.

4.5.3 Data Warehouse

The data warehouse is a Microsoft SQL Server 2005 relational database. This database, and all other "CH" tools used, has a data structure designed to achieve compliance with the Environmental Restoration Program Information Management System (ERPIMS) standard specified by Air Force Center for Engineering and the Environment (AFCEE). ERPIMS is an effective, comprehensive standard for environmental management.

The warehouse will use valid value tables when applying reference attributes to project data. Such reference data include the names of site objects and sampling locations, sampling matrix and method categories, analyte names, units. These reference tables are critical for maintaining the completeness and accuracy of data sets and are essential for accurate querying of the data.

Data are loaded and stored so that relationships among categories of data are enforced. For instance, all sampling records must be associated with a valid site object such as a planned sediment sampling location. The project repository database and collection, analysis, and reporting tools used in the DBMS are designed to enforce, for any project data record, entries in fields that refer to other types of data as required by the overall data model.

4.6 Data Reporting

Data reporting includes the following tasks:

- Retrieving data from the data warehouse for project deliverables, data visualization, or consumption by third parties
- Reviewing initial data and producing data queries and draft reports to dissect and disassemble the data
- Producing any requested client and regulatory agency data deliverables

Data for project deliverables, data visualization, or consumption by third parties will be retrieved from the warehouse, and will be equivalent to the real-time state of the project repository database. PMs and GIS Analysts (GAs) will work with the EIS and PCL for quality queries and data for reports.

4.6.1 Tables, Figures, and Diagrams

Once the data have been sufficiently analyzed, the list of requested data reports (tables, figures, diagrams) can be developed and finalized by the project team and submitted to the PCL and PM for review.

All requests for figures or graphics are to be directed to the GA assigned as the Point of Contact (POC) for that particular Navy installation. All requests for analytical data (crosstab tables, data dumps, third party deliverables etc) should be directed to the EIS assigned as the POC for that particular Navy installation. The EIS will generate a data deliverable from the data warehouse or NIRIS (as needed) suitable for end use and will provide data support to the end user. All requests for data statistics and calculations should be directed to the Risk Assessor assigned to the project.

4.6.2 GIS

The Navy CLEAN program will utilize ESRI's suite of GIS software for the majority of GIS-related tasks. The GIS data model will consist of one or more geodatabases (GDBs) per installation. Each installation will maintain one common installation GDB, which will store the common infrastructure data such as buildings, roads, topography, hyrdography, utilities, etc. The common installation GDB should adhere, as much as possible, to the Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) data model. All project specific GDBs shall be developed and named for ease of interpretation by the GA.

All station location information for each installation will be pulled directly from the data warehouse and stored in the common installation GDB as a data table. The data warehouse must contain valid coordinate information for the locations to be displayed correctly. Valid coordinate information will be maintained in the data warehouse by the EIS, and updated as necessary by the DBS.

ESRI's ArcMap 9.3 (or the latest version available) will be utilized for spatially displaying the environmental data within maps and figures, as well as for spatial analysis. The GA will need to coordinate efforts with the EIS on all requests that require the display of environmental sample data on a map to ensure that the appropriate data is queried from the data warehouse and linked to the appropriate station location table within the GIS.

4.6.3 Site Information Management System

This is currently not being used on the Navy CLEAN and Joint Venture Programs.

SIMS is a tool for publishing data of sufficient quality from the project. However, the project data warehouse will remain the database of record for the project.

SIMS provides many standard report formats, all of which are used in conjunction with the Query Tool feature, to isolate and retrieve information. Users can generate and save their queries using a graphical point-and-click tool. Reports in a wide variety of formats also can be requested and produced.

4.6.4 Legacy Data

Legacy data are those collected from any contractor other than CH2M HILL and data collected by CH2M HILL that have not been managed in accordance with Navy CLEAN and Joint Venture Program requirements. Legacy data are commonly compiled from various electronic and hard copy sources including spreadsheets, databases, technical reports, and laboratory hard copy data reports. When working with legacy data, usability assessment must be completed for the project team to be able to use the data with confidence. In order to assess the data properly, the legacy data needs to be evaluated by skilled professionals that are familiar with the type of data being evaluated so that any errors identified in the data can be corrected when possible or qualified in a manner to reflect the limitations of the data's use.

The PM has overall responsibility for the selection for inclusion of legacy data into the data management process. The PDL and PCL will work with the PM to establish the data review and import process, compile a comprehensive data inventory, and identify staff to facilitate data review.

The PDL and PCL will work with the EIS to determine the appropriate intermediary files and tools used to collect the data. The PDL and PCL will oversee the data review and flagging process and approve the data for upload into the Data Warehouse. The EIS is responsible for assembling the field and laboratory data in formats that facilitate data review, aid the PDL and PCL in overseeing the data review and flagging process, schedule, conversion of the data to the proper data warehouse format, and then loading the data into the Data Warehouse after approval by the PDL and PCL.

The GA, PDL, PCL, and PM have the primary responsibility for reviewing the data in their area of expertise and providing the PCL with data usability flags to be associated with each record.

SECTION 5

Project Closeout

The project completion/closeout phase includes the following:

- Archive hard copy and electronic documents
- Conduct project closeout meeting

5.1 Archive Procedures

A large variety of technical data will be generated during the field investigations. The EIS and PC will collect all hard copy and electronic data they are responsible for and verify that the incoming records are legible and in suitable condition for storage. Record storage will be performed in two stages:

- Storage during the project
- Permanent storage following project completion

During the project, CH2M HILL will store data hardcopy reports in CH2M HILL offices. Physical records will be secured in steel file cabinets or shelves, and labelled with the appropriate project identification. Electronic data will be maintained on CH2M HILL's corporate local area network servers.

Information generated from field activities will be documented on appropriate forms and will be maintained in the project file. These include COC records, field logbooks, well construction forms, boring logs, location sketches, and site photographs. In addition, notes from project meetings and telephone conversations will be filed.

Following project completion, both hard copy and electronic data deliverables will be archived. Team staff will provide all hard copies of laboratory and validation reports to the Data Closeout Coordinator to be prepped and shipped to Stone Mountain for archiving. Final laboratory SNEDDs and loading files will be provided to the PDL, to be archived on CH2M HILL's corporate local area network servers.

Any modifications made to the tools will be communicated to the project team via e-mail. As revisions are finalized, they will be distributed electronically to all users. After revision, it is the user's responsibility to conform to revised portions of the DMP.

5.2 Invoice Review and Approval

The EIS is responsible for tracking all data deliverables throughout the data management process to ensure that the project schedule is maintained, subcontractors comply with all required turn around times, and data provided are complete and acceptable. Following project completion, EISs are to review and provide comments on all laboratory and data validator invoices regarding data quality and schedule compliance prior to approval by the PM.

5.3 Project Closeout

At the end of each project, the PM will notify team staff of project closeout. The PM will coordinate and verify that all pertinent data has been archived. The PM may also review lessons learned, suggest process improvements, or revisions to the DMP and other project documentation as deemed necessary.

Appendix A
Environmental Data Management Work Process

Environmental Data Management Work Process

1.0 Project Planning & Setup	2.0 Sample Collection & Management	3.0 Lab Analysis	4.0 Data Validation	5.0 Data Management	6.0 Data Evaluation & Reporting
1.1 Project Setup	2.1 Sample Management	3.1 Sample Analysis	4.1 Internal Chemical Data Validation	5.1 CH2M HILL Data	6.1 Data Prep & Processing for Reporting
1.2 QAPP, SAP, DMP, DQOs Integration	2.2 Sample Collection	3.2 EDD Management	4.2 External Chemical Data Validation	5.2 Other Contractor & Legacy Data	6.2 Tabular Data Queries & Reports
1.3 Laboratory Setup	2.3 Sample Data Management	3.3 Hard Copy Management	4.3 Senior Review of Validated Data	5.3 Database Maintenance & Administration	6.3 Field Logs and Graphs
1.4 Database Setup					6.4 GIS Queries and Maps

Appendix B
Life of a Sample

A Sample's Life

Step-by-Step Outline of Navy CLEAN and JV Data Management Process, and Roles & Responsibilities

Step 1

Planning Phase

- Staffing Schedules
- Kickoff Meeting – Include the EIS & PC
- Project Instructions (PIs)
  - Sample Nomenclature provided in table
  - Reviewed by DMC (Chelsea Bennet) or Database Specialist

Step 2A

Sample Collection

- Daily collection and shipments of samples
- One COC/cooler; One FedEx slip/cooler
- Coordinate w/ EIS for tracking & Lab notification
- GPS conducted (if applicable)

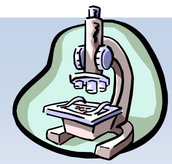
Step 2B

Sample Tracking

- EIS cross checks COC against PIs
- Also reviews lab confirmation sheets to verify all samples were received and in appropriate condition

Step 3

Lab Analysis



- Standard 28-day unless otherwise arranged
- EIS reviews data for accuracy and works with lab to resolve discrepancies
- EIS tracks schedule and keeps PM informed
- EIS inputs STSP information from Log Books
- EIS can generate Unvalidated Raw and Detects Data Tables

Step 4

Data Validation

- PC reviews all data for accuracy against the PIs
- PC sends data from lab to Data Validator
- Delays may occur if there is missing data or data is late from the lab\
- EIS can generate Validated Raw and Detects Data Tables

Step 5

Data Load

- PCL sends data to Database Specialist to be loaded into the Data Warehouse (DW)
- (Sometimes this involves assistance from PM, FTL, PC, and/or EIS)

Step 6

Quality Assurance/ Quality Control

- EIS & PC are notified that data is loaded
- EIS verifies info loaded is correct (Sample, Station, Analyses, Result)
- EIS then helps decide whether info needs to be updated or not
- File and archive all Lab and DV deliverables

Step 7

Report Generation

- Raw, Detects, Exceedance Reports
- Data Requests
- Exceedance Reports (criteria needed prior to this step and selected by PM)
- Human Health Risk Assessment
- Eco Risk Assessment

End of our Sample's Life?

- Data may be used in reports, posted on web, put into GIS, etc
- In that regard, a sample's life doesn't really ever end!
- Hopefully our sample had no exceedances and everyone is happy.

Appendix C
Standard Operating Procedures

Checklist – Archive and NIRIS Load Prep

Checklist – Data QC

Checklist - EIS Project Start-up Questions

Checklist - Generating RDE Tables

Checklist - Historic Data Cleanup

Checklist - SNEDD DM Process

Roles – Data Management Coordinator

Roles – EIS

Roles – Project Manager

Template – STS & QC Association Table

SOP-114 - CHIMPTool

SOP-126 - XTab Reports Tool

SOP - Access to NIRIS

SOP - Cherry Point Exceedance Formatting Wizard

SOP – CLEAN SNEDD Loading with CHIMPTool

SOP - Corrections to File

SOP - Data Archiving Procedures

SOP - Data Shipping

SOP – FDET

SOP – FDET Setup

SOP – NIRIS Importer Validator Tool

SOP – SVMTool

SOP – Valid Value Setup

Appendix D
Electronic Data Deliverable Specifications

CH2M HILL SNEDD Format			
Field Name	**Field Format**	**REQ**	**Field Description**
Contract_ID	A13	R	Contract ID assigned by Division Contracting Office, not including dashes. Found on Statement of Work. (e.g. D459559365800)
DO_CTO_Number	A4	R	CTO or TO # assigned by Navy. (e.g. CTO-12 = 0012, TO-54 = TO54)
Phase	A8	NR	Task Phase, SubTask Number or Annual Quarter. (e.g. QTR1)
Installation_ID	A20*	R	Unique identifier for installation. (e.g. WHIDBEY)
Sample_Name	A50	R	CH2M HILL Sample ID (from Chain Of Custody).
CH2M_Code	A4*	R	CH2M HILL Preparation Method Code (e.g. NONS)
Analysis_Group	A9*	R	The CH2M HILL code for the analysis performed on the sample.
Analytical_Method	A20*	R	Analytical Method used to analyze sample fraction. (e.g. 6010)
PRC_Code	A15*	R	NIRIS code for the analytical method category (e.g. PCHAR)
Lab_Code	A10*	R	CH2M HILL Code assigned to the laboratory (e.g. COMP)
Lab_Name	A50*	R	The name of the laboratory that conducted the analysis, in all CAPS.
Leachate_Method	A16*	RA	Code for the leachate method used on sample. (e.g. SW1310)
Sample_Basis	A16*	R	Sample basis of analysis; wet weight, dry weight etc. (e.g. DRY)
Extraction_Method	A16*	RA	Code for the extraction method used on sample. (e.g. FLTRES)
Result_Type	A16*	R	Type of results; dilution, reanalysis etc. (e.g. 000)
Lab_QC_Type	A15*	R	Code for Laboratory Sample (MS, MSD, LBLK, LCS)
Sample_Medium	A16*	R	Sample medium reported by the laboratory. (e.g. L)
QC_Level	A16*	R	QC Level of data package : EPA levels I to IV. (e.g. 3)
DateTime_Collected	MM/DD/YYYY 00:00	R	Date and time sample was collected. Use 24 hour clock. (e.g. 02/13/2007 15:34)
Date_Received	MM/DD/YYYY	R	The date the sample was received in the lab (in 10 characters). (e.g. 03/24/2007)
Leachate_Date	YYYYMMDD	RA	Date the sample was leached. Req'd if sample was leached and/or Leachate Method provided. (e.g. March 12, 2007 = 20070312)
Leachate_Time	HH:MM:SS	RA	Time the sample was leached. Use 24 hour clock, with 8 characters. (e.g. 14:30:05). Req'd if sample was leached and/or Leachate Method provided.
Extraction_Date	YYYYMMDD	RA	Date that the lab extracted the sample. Req'd if Extraction Method provided.
Extraction_Time	HH:MM:SS	RA	Time of day lab extracted the sample. Use 24 hour clock, with 8 characters. Req'd if Extraction Method provided. (e.g. 02:15:00)
Analysis_Date	YYYYMMDD	R	Date that the lab performed the analysis.
Analysis_Time	HH:MM:SS	R	Time of day that the lab extracted the sample. Use 24 hour clock, with 8 characters.
Lab_Sample_ID	A20	R	Unique ID assigned to the sample by the laboratory.
Dilution	N10,2	R	Dilution factor used. Default value is 1 (e.g. 10)

CH2M HILL SNEDD Format			
Field Name	**Field Format**	**REQ**	**Field Description**
Run_Number	N4	R	Number distinguishing multiple or repeat analyses by the same method (incl. RA, RE, DL, etc). Must be equal to or greater than 1.
Percent_Moisture	N6,3	RA	Percent moisture of the sample. (e.g. 20)
Percent_Lipid	N6,3	RA	Percent lipid of the sample.
Chem_Name	A55*	R	The name of the compound being analyzed.
Analyte_ID	A20*	R	Analyte ID (CAS Number) assigned to the analyte. (e.g. 7440-47-3)
Analyte_Value	N18,7	R	Leave Blank for Validator to enter the final analyte concentration.
Original_Analyte_Value	N18,7	R	Analyte concentration value originally generated by the Laboratory.
Result_Units	A16*	R	Unit of measure for the analyte value. (e.g. UG_L)
Lab_Qualifier	A16*	RA	Lab data qualifier. Values will not be rejected if not in domain table.
Validator_Qualifier	A16*	RA	Leave blank for Validator. Values will not be rejected if not in domain table.
GC_Column_Type	A16*	RA	Data code for the type of GC column used in an analysis.
Analysis_Result_Type	A4*	R	Type of analysis performed (allowed: SURR or TRG).
Result_Narrative	A120	RA	Additional information or comments associated with the result.
QC_Control_Limit_Code	A16*	RA	Type of quality control limit. Req'd if QC criteria and upper/lower accuracy included. (e.g. CLPA)
QC_Accuracy_Upper	N6,3	RA	Upper QC limit of % recovery as measured for a known target analyte spiked into a QC sample. (e.g. 25.45)
QC_Accuracy_Lower	N6,3	RA	Lower QC limit of % recovery as measured for a known target analyte spiked into a QC sample. (e.g. 10.15)
Control_Limit_Date	YYYYMMDD	RA	Date a control limit is established.
QC_Narrative	A120	RA	Leave blank for Validator. Enter DV_Qual_Code.
MDL	N18,7	RA	Method Detection Limit
Detection_Limit	N18,7	RA	Reported Detection Limit
SDG	A50	R	Lab code for a group of samples in a data deliverable package.
Analysis_Batch	A20	R	Laboratory code for a batch of analyses analyzed together.
Validator_Name	A50*	R	Leave Blank. Name of Validator in all CAPS. (e.g. CONTRACTOR INC.)
Val_Date	YYYYMMDD	RA	Populated by Validator/Reviewer. Validation/Review QC date.

Appendix E
Health and Safety Plan

Project-Specific Health and Safety Plan
Sites 7 and 32
Supplemental Investigations

Naval Weapons Station Yorktown
Yorktown, Virginia

Contract Task Order WE29

August 2012

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Under the

NAVFAC CLEAN 1000 Program
Contract N62470-08-D-1000

Prepared by

CH2MHILL

Virginia Beach, Virginia

Content

Figures

Attachments

Approval

This site-specific Health and Safety Plan (HSP) has been written for use by CH2M HILL only. CH2M HILL claims no responsibility for its use by others unless that use has been specified and defined in project or contract documents. The plan is written for the specific site conditions and identified scope(s) of work and must be amended if those conditions or scope(s) of work change.

By approving this HSP, the Responsible Health and Safety Manager (RHSM) certifies that the personal protective equipment has been selected based on the project-specific hazard assessment.

Original Plan

RHSM Approval: Mark Orman, CSP, ARM, CHMM **Date**: 02/07/2011

Project Manager Approval: Adam Forshey **Date:**

Revisions

Revisions Made By: Carl Woods, Stephanie DeWitt **Date:** 10/04/2011

Description of Revisions to Plan: Revisions made per the Department of the Navy Reviewer's comments. Changes included: added a Sanitation Plan section, added names of Subcontractors, added maps of the site, revised the heat stress monitoring and air monitoring sections.

Revisions Approved By: Mary Anderson **Date:** 10/12/11

Revisions Made By: Kimberley Coke/Carl Woods **Date:** 1/12/12

Description of Revisions to Plan: Update plan to obtain new approval, ensure plan addresses well installation and soil sampling. Ensure winter protocols are captured instead of summer and added/updated any new corporate initiatives.

Revisions Approved By: Carl Woods **Date:** 1/17/12

SECTION 1

Introduction

CH2MHILL

HSSE TargetZero

Health, Safety, Security and Environment Policy

Protection of people and the environment is a CH2M HILL core value. It is our vision to create a culture within CH2M HILL that empowers employees to drive this value into all global operations and achieve excellence in health, safety, security and environment (HSSE) performance. CH2M HILL deploys an integrated, enterprise-wide behavior based HSSE management system to fulfill our mission and the expectations of our clients, staff, and communities based on the following principles:

- We require all management and supervisory personnel to provide the leadership and resources to inspire and empower our employees to take responsibility for their actions of their fellow employees to create a safety, healthy, secure and environmentally-responsible workplace.
- We provide value to clients by tailoring HSSE processes to customer needs and requiring all CH2M HILL employees and subcontractors to delivery projects with agility, personal service, and responsiveness and in compliance with HSSE requirements and company standards to achieve health, safety, and security and pollution prevention excellence. Our performance will aspire to influence others and continually redefine world-class HSSE excellence.
- We systematically evaluate our design engineering and physical work environment to verify safe and secure work conditions and practices are established, consistently followed, and timely corrected.
- We continually assess and improve our HSSE program to achieve and maintain world-class performance by setting and reviewing objectives and targets, reporting performance metrics, and routinely reviewing our program.
- We care about the safety and security of every CH2M HILL employee and expect all employees to embrace our culture, share our core value for the protection of people and the environment, understand their obligations, actively participate, take responsibility, and "walk the talk" on and off the job.

The undersigned pledge our leadership, commitment, and accountability for making this policy a reality at CH2M HILL.

Dated the 29th date of March, 2011.

Lee McIntire
Chief Executive Officer

John Madia
Chief Human Resources Officer

Mike Lucki
Chief Financial Officer

Margaret McLean
Chief Legal Officer

Mike McKelvy
President, Government, Environment, & Nuclear Division

Bob Card
President, Energy & Water Division

Jacqueline Rast
President, Facilities & Infrastructure Division

Fred Brune
President, International Division

Gene Lupia
President, Delivery Excellence

Keith Christopher
Senior Vice President, Health, Safety, Security and Environment

1.1 CH2M HILL Policy and Commitment

1.1.1 Safe Work Policy

It is the policy of CH2M HILL to perform work in the safest manner possible. Safety must never be compromised. To fulfill the requirements of this policy, an organized and effective safety program must be carried out at each location where work is performed.

CH2M HILL believes that all injuries are preventable, and we are dedicated to the goal of a safe work environment. To achieve this goal, every employee on the project must assume responsibility for safety.

Every employee is empowered to:

- Conduct their work in a safe manner;
- Stop work immediately to correct any unsafe condition that is encountered; and
- Take corrective actions so that work may proceed in a safe manner.

Safety, occupational health, and environmental protection will not be sacrificed for production. These elements are integrated into quality control, cost reduction, and job performance, and are crucial to our success.

1.1.2 Health and Safety Commitment

CH2M HILL has embraced a philosophy for health and safety excellence. The primary driving force behind this commitment to health and safety is simple: employees are CH2M HILL's most significant asset and CH2M HILL management values their safety, health, and welfare. Also, top management believes that all injuries are preventable. CH2M HILL's safety culture empowers employees at all levels to accept ownership for safety and take whatever actions are necessary to eliminate injury. Our company is committed to world-class performance in health and safety and also understands that world-class performance in health and safety is a critical element in overall business success.

CH2M HILL is committed to the prevention of personal injuries, occupational illnesses, and damage to equipment and property in all of its operations; to the protection of the general public whenever it comes in contact with the Company's work; and to the prevention of pollution and environmental degradation.

Company management, field supervisors, and employees plan safety into each work task in order to prevent occupational injuries and illnesses. The ultimate success of CH2M HILL's safety program depends on the full cooperation and participation of each employee.

CH2M HILL management extends its full commitment to health and safety excellence.

1.1.3 Project-Specific Health, Safety, and the Environment Goals

All management and employees are to strive to meet the project-specific Health, Safety, and the Environment (HSE) goals outlined below. The team will be successful only if everyone makes a concerted effort to accomplish these goals. The goals allow the project to stay focused on optimizing the health and safety of all project personnel and, therefore, making the project a great success.

The Project has established eleven specific goals and objectives:

- Create an injury-free environment;
- Have zero injuries or incidents;
- Provide management leadership for HSE by communicating performance expectations, reviewing and tracking performance, and leading by example;
- Ensure effective implementation of the HSP through education, delegation, and team work;
- Ensure 100 percent participation in HSE compliance;

- Continuously improve our safety performance;
- Maintain free and open lines of communication;
- Make a personal commitment to safety as a value;
- Focus safety improvements on high-risk groups;
- Continue strong employee involvement initiatives; and
- Achieve health and safety excellence.

SECTION 2
Applicability

This HSP applies to:

- All CH2M HILL staff, including subcontractors and tiered subcontractors of CH2M HILL working on the site; and
- All visitors to the construction site in the custody of CH2M HILL (including visitors from the Client, the Government, the public, and other staff of any CH2M HILL company).

This HSP does not apply to the third-party contractors, their workers, their subcontractors, their visitors, or any other persons not under the direct control or custody of CH2M HILL.

This HSP defines the procedures and requirements for the health and safety of CH2M HILL staff and visitors when they are physically on the work site. The work site includes the project area (as defined by the contract documents) and the project offices, trailers, and facilities thereon.

This HSP will be kept onsite during field activities and will be reviewed as necessary. The HSP will be amended or revised as project activities or conditions change or when supplemental information becomes available. The HSP adopts, by reference, the Enterprise-wide Core Standards and Standard Operating Procedures (SOPs), as appropriate. In addition, the HSP may adopt procedures from the project Work Plan and any governing regulations. If there is a contradiction between this HSP and any governing regulation, the more stringent and protective requirement shall apply.

All CH2M HILL staff and subcontractors must sign the employee sign-off form included in this document as Attachment 1 to acknowledge review of this document. Copies of the signature page will be maintained onsite by the Safety Coordinator (SC).

This HSP has been revised and edited to meet the requirements of the fore mentioned references per a conference call with Navy Reviewers and CH2M HILL personnel on September 14, 2011.

Ref: (a) 29 CFR 1910.120 (Hazardous Waste Operations and Emergency Response)
(b) 29 CFR 1926.65 (Hazardous Waste Operations and Emergency Response)
(c) Department of the Navy Environmental Restoration Program Manual (August 2006)
(d) U. S. Army Corps of Engineers, Safety and Health Requirements Manual, EM 385-1-1

SECTION 3

General Project Information

3.1 Project Information and Background

Project Number: **408244**

Client: Department of the NAVY, Atlantic Division

Project/Site Name: Yorktown Naval Weapons Station; Sites 7 and 32

Site Address: Yorktown Naval Weapons Station, Yorktown, Virginia

CH2M HILL Project Manager: Mary Anderson

CH2M HILL Office: Virginia Beach

DATE HSP Prepared: 02/07/2011, Revised 1/12/12

Date(s) of Site Work: July 2011 – July 2012

3.2 Site Background and Setting

WPNSTA Yorktown is situated within the Virginia Coastal Plain Physiographic Province. The topography of NWPNSTA Yorktown is generally flat with some gentle slopes. However, in the areas adjacent to water bodies there are gentle to steep slopes toward the various tributaries. Most of the areas are open fields surrounded by woods. Sites 7 and 32 are located on the lower terrace, Croaker Flat.

The Site 7 boundary, as defined by the 1984 Initial Assessment Study (IAS), consists of the 300-foot long drainage area downgradient of Building 375. The drainage area received untreated explosives-contaminated wastewater until 1973, when a water treatment system was installed to treat effluent prior to discharge. After 1986, the treated wastewater was redirected to the sanitary sewer system and ultimately to Hampton Roads Sanitation District. Subsequent investigations identified the drainage area as the primary source of contamination at Site 7 due to elevated concentrations of explosives in soil and sediment. A Pilot Study was conducted to fully delineate the extent of explosives contamination within the Site 7 boundary and to excavate contaminated soils and sediment for treatment. Following the completion of the Pilot Study removal action, a ROD was signed in 1998 affirming that soil and sediment within the site boundary had been remediated to levels protective of future industrial land use. However, during previous investigation activities, the upgradient buildings were inaccessible because Plant 3 remained in operation. In 2010, the WPNSTA Yorktown Partnering Team evaluated the site as part of the Long-term Monitoring (LTM) program and considered that an ongoing source of contamination to the discharge area may still be present beneath the former footprints of the buildings that are upgradient.

Site 32, no historical releases have been reported or documented during the operation of the STP, but beaded elemental mercury was discovered around the base of the trickling filter during excavation of the structure. The source of this mercury was likely the mercury-containing bearings located in the distributor arms of the trickling filter tank. Based on anecdotal evidence, a total of twelve drums of mercury-contaminated soils were excavated and disposed of during the removal of the trickling filter and the site was backfilled to regrade. However, no documentation of the removal activities was conducted, confirmation samples collected, or the depth of fill exists. Contamination to downgradient sediment and surface water has been addressed as part of previous investigations and a subsequent removal action in 2009, which also included the placement of additional fill across the terrestrial area to restore grade. Therefore, these media will not be addressed as part of this SI or discussed further in this SAP, but contaminants of concern identified in these media will be used to inform the current investigation activities.

Site Size: Site 7, Plant 3 Explosives-Contaminated Wastewater Discharge Area – 24.8 acres

Site 32, Wetlands area down gradient of Beaver Pond, formerly SSA25 – 1.4 acre

3.3 Description of Tasks

All CH2M HILL and Subcontractor employees engaging in hazardous waste operations (HAZWOPER) or emergency response shall receive appropriate training as required by 29 CFR 1910.120 and 29 CFR 1926.65 (or if required by Subcontract). Personnel who have not met these training requirements shall not be allowed to engage in hazardous waste operations or emergency response activities. See the following tasks that fall under HAZWOPER requirements.

3.3.1 Hazwoper-Regulated Tasks

- Well Drilling
- Monitoring Well Groundwater Sampling
- Pore Water Sampling
- DPT Groundwater Sampling
- Investigative Derived Waste (IDW) sampling and disposal
- Monitoring Well Installation
- Soil Sampling
- Surface Water Sampling
- Sediment Sampling

3.3.2 Non-Hazwoper-Regulated Tasks

Under specific circumstances, the training and medical monitoring requirements of federal or state Hazwoper regulations are not applicable. The following tasks do not involve exposure to safety or health hazards associated with the hazardous waste operations. Hazwoper training or medical requirements do not apply for the tasks listed below.

TASKS	CONTROLS
• Survey • Utility locate	• Brief on hazards, limits of access, and emergency procedures. • Post areas of contamination as appropriate. • Perform air sampling/monitoring as specified in this HSP.

SECTION 4

Project Organization and Responsibilities

4.1 Client NAVFAC

Contact Name: James Gravette
Phone: (757) 341-0477

4.2 CH2M HILL

4.2.1 Project Manager

Project Manager Name: Mary Anderson
Job Title: PM
CH2M HILL Office: VBO
Telephone Number: +1 (518) 982-0572
Cellular Number: +1 (757) 870-2762

The project manager (PM) is responsible for providing adequate resources (budget and staff) for project-specific implementation of the HSE management process. The PM has overall management responsibility for the tasks listed below. The PM may explicitly delegate specific tasks to other staff, as described in sections that follow, but retains ultimate responsibility for completion of the following in accordance with this document:

- Incorporate standard terms and conditions, and contract-specific HSE roles and responsibilities in contract and subcontract agreements (including flow-down requirements to lower-tier subcontractors).
- Select safe and competent subcontractors by:

Choosing potential subcontractors based on technical ability and HSE performance;
Implementing the subcontractor prequalification process;
Ensuring that acceptable certificates of insurance, including CH2M HILL as named additional insured, are secured as a condition of subcontract award; and
Ensuring HSE submittals, subcontract agreements, and appropriate site-specific safety procedures are in place and accepted prior field mobilization.

- Ensure copies of training and medical monitoring records, and site-specific safety procedures are being maintained in the project file accessible to site personnel.
- Provide oversight of subcontractor HSE practices per the site-specific safety plans and/or procedures.
- Manage the site and interfacing with 3rd parties in a manner consistent with the contract and subcontract agreements and the applicable standard of reasonable care.
- Ensure that the overall, job-specific, HSE goals are fully and continuously implemented.
- Support and implement use of stop-work orders when subcontractor safety performance is not adequate.

4.2.2 CH2M HILL Responsible Health and Safety Manager

RHSM Name: Mark Orman, CSP, ARM, CHMM
Job Title: Federal Sector HSM
CH2M HILL Office: MKE
Telephone Number: 414-847-0597
Cellular Number: 414-712-4138

The RHSM is responsible for the following:

- Review and evaluate subcontractor HSE performance using the pre-qualification process;
- Approve HSP and its revisions as well as Activity Hazard Analyses (AHA);
- Review and evaluate subcontractor site-specific safety procedures for adequacy prior to start of subcontractor's field operations;
- Support the oversight (or SC's direct oversight) of subcontractor and tiered subcontractor HSE practices;
- Permit upgrades/downgrades in respiratory protection after reviewing analytical data;
- Conduct audits as determined by project schedule and coordination with PM; and
- Participate in incident investigations, lessons learned, loss/near loss reporting.

4.2.3 CH2M HILL Safety Coordinator

SC Name: Mark Ost
Job Title: Geologist
CH2M HILL Office: VBO
Telephone Number: 757-671-6247
Cellular Number: 757-362-4597

The SC is responsible for verifying that the project is conducted in a safe manner including the following specific obligations:

- Verify this HSP is current and amended when project activities or conditions change;
- Verify CH2M HILL site personnel and subcontractor personnel read the HSP and sign the Employee Sign-Off Form, prior to commencing field activities;
- Verify CH2M HILL site personnel have completed any required specialty training (for example, fall protection, confined space entry, among others) and medical surveillance as identified in this HSP;
- Verify that project files available to site personnel include copies of executed subcontracts and subcontractor certificates of insurance (including CH2M HILL as named additional insured), bond, contractor's license, training and medical monitoring records, and accepted site-specific safety procedures prior to start of subcontractor's field operations;
- Act as the project "Hazard Communication Coordinator" and perform the responsibilities outlined in the HSP;
- Act as the project "Emergency Response Coordinator" and perform the responsibilities outlined in the HSP;
- Post the Occupational Safety and Health Administration (OSHA) job-site poster; the poster is required at sites where project field offices, trailers, or equipment-storage boxes are established;
- Hold and/or verify that safety meetings are conducted and documented in the project file initially and as needed throughout the course of the project (as tasks or hazards change);
- Verify that project health and safety forms and permits are being used as outlined this HSP;

- Perform oversight and assessments of subcontractor HSE practices per the site-specific safety plan and verify that project activity self-assessment checklists are being used as outlined this HSP;
- Coordinate with the RHSM regarding CH2M HILL and subcontractor operational performance, and 3rd party interfaces;
- Verify appropriate personal protective equipment (PPE) use, availability, and training;
- Ensure that the overall, job-specific, HSE goals are fully and continuously implemented;
- Conduct accident investigations including root cause analysis;
- Calibrate and conduct air monitoring in accordance with the HSP; maintain all air monitoring records in project file;
- Maintain HSE records and documentation;
- Facilitate OSHA or other government agency inspections including accompanying inspector and providing all necessary documentation and follow-up;
- Deliver field HSE training as needed based on project-specific hazards and activities;
- Contact the RHSM and PM in the event of an incident;
- When an apparent imminent danger exists, immediately remove all affected CH2M HILL employees and subcontractors, notify subcontractor safety representative, stop affected work until adequate corrective measures are implemented, and notify the PM and RHSM as appropriate; and
- Document all verbal health and safety-related communications in project field logbook, daily reports, or other records.

4.3 CH2M HILL Subcontractors

(Reference CH2M HILL SOP HSE-215, *Contracts and Subcontracts)*

Subcontractor: Parratt Wolff Subcontractor Contact Name: Butch Stephens Telephone: 800-627-7920 Subcontractor: Michael's Surveying Subcontractor Contact Name: Paul Michael Telephone: 757-873-1762 Subcontractor: Accumark Subcontractor Contact Name: Valerie Mayhew Telephone: 804-550-7740

Subcontractors must comply with the following activities, and are responsible to:

- Comply with all local, state, and federal safety standards;
- Comply with project and owner safety requirements;
- Actively participate in the project safety program and either hold or attend and participate in all required safety meetings;
- Provide a qualified safety representative to interface with CH2M HILL;
- Maintain safety equipment and PPE for their employees;
- Maintain and replace safety protection systems damaged or removed by the subcontractor's operations;

- Notify the SC of any accident, injury, or incident immediately and submit reports to CH2M HILL within 24 hours;
- Install contractually required general conditions for safety (for example, handrail, fencing, fall protection systems, floor opening covers);
- Conduct and document weekly safety inspections of project-specific tasks and associated work areas;
- Conduct site-specific and job-specific training for all subcontractor employees, including review of the CH2M HILL HSP, subcontractor HSPs, and subcontractor AHAs and sign appropriate sign-off forms; and
- Determine and implement necessary controls and corrective actions to correct unsafe conditions.

The subcontractors listed above may be required to submit their own site-specific HSP and other plans such as lead or asbestos abatement compliance plans. Subcontractors are responsible for the health and safety procedures specific to their work, and are required to submit their plans to CH2M HILL for review and acceptance before the start of field work.

Subcontractors are also required to prepare AHAs before beginning each activity posing hazards to their personnel. The AHA shall identify the principle steps of the activity, potential health and safety hazards for each step and recommended control measures for each identified hazard. In addition, a listing of the equipment to be used to perform the activity, inspection requirements, and training requirements for the safe operation of the equipment listed must be identified.

4.4 Employee Responsibilities

All personnel are assigned responsibility for safe and healthy operations. This concept is the foundation for involving all employees in identifying hazards and providing solutions. For any operation, individuals have full authority to stop work and initiate immediate corrective action or control. In addition, each worker has a right and responsibility to report unsafe conditions or practices. This right represents a significant facet of worker empowerment and program ownership. Through shared values and a belief that all accidents are preventable, our employees accept personal responsibility for working safely.

Each employee is responsible for the following performance objectives:

- Perform work in a safe manner and produce quality results;
- Perform work in accordance with company policies, and report injuries, illnesses, and unsafe conditions;
- Complete work without injury, illness, or property damage;
- Report all incidents immediately to supervisor, and file proper forms with a human resources representative;
- Report all hazardous conditions and/or hazardous activities immediately to supervisor for corrective action; and
- Complete an HSE orientation prior to being authorized to enter the project work areas.

4.4.1 Employee Authority

Each employee on the project has the obligation and authority to shut down any perceived unsafe work and during employee orientation, each employee will be informed of their authority to do so.

4.5 Client Contractors

(Reference CH2M HILL SOP HSE-215, *Contracts, Subcontracts and HSE Management Practices*)

Contractor: _______NA_________
Contact Name: ____________________
Telephone: ____________________
Contractor Task(s): ____________________

Contractor: ____________________
Contact Name: ____________________
Telephone: ____________________
Contractor Task(s): ____________________

This HSP does not cover contractors that are contracted directly to the client or the owner. CH2M HILL is not responsible for the health and safety or means and methods of the contractor's work, and we must never assume such responsibility through our actions (such as advising on health and safety issues). In addition to these instructions, CH2M HILL team members should review contractor safety plans so that we remain aware of appropriate precautions that apply to us. Self-assessment checklists are to be used by the SC and CH2M HILL team members to review the contractor's performance only as it pertains to evaluating CH2M HILL exposure and safety. The RHSM is the only person who is authorized to comment on or approve contractor safety procedures.

Health and safety-related communications with contractors should be conducted as follows:

- Request the contractor to brief CH2M HILL team members on the precautions related to the contractor's work;
- When an apparent contractor non-compliance or unsafe condition or practice poses a risk to CH2M HILL team members:
- Notify the contractor safety representative;
- Request that the contractor determine and implement corrective actions;
- If necessary, stop affected CH2M HILL work until contractor corrects the condition or practice; and
- Notify the client, PM, and RHSM as appropriate.

If apparent contractor non-compliance or unsafe conditions or practices are observed, inform the contractor safety representative (CH2M HILL's obligation is limited strictly to informing the contractor of the observation; the contractor is solely responsible for determining and implementing necessary controls and corrective actions).

If an apparent imminent danger is observed, immediately warn the contractor employee(s) in danger and notify the contractor safety representative (CH2M HILL's obligation is limited strictly to immediately warning the affected individual(s) and informing the contractor of the observation; the contractor is solely responsible for determining and implementing necessary controls and corrective actions).

All verbal health and safety-related communications will be documented in project field logbook, daily reports, or other records.

SECTION 5

Standards of Conduct

All individuals associated with this project must work injury-free and drug-free and must comply with the following standards of conduct, the HSP, and the safety requirements of CH2M HILL. Commonly accepted standards of conduct help maintain good relationships between people. They promote responsibility and self-development. Misunderstandings, frictions, and disciplinary action can be avoided by refraining from thoughtless or wrongful acts.

5.1 Standards of Conduct Violations

All individuals associated with this project are expected to behave in a professional manner. Violations of the standards of conduct would include, but not be limited to:

- Failure to perform work;
- Inefficient performance, incompetence, or neglect of work;
- Willful refusal to perform work as directed (insubordination);
- Negligence in observing safety regulations, poor housekeeping, or failure to report on-the-job injuries or unsafe conditions;
- Unexcused or excessive absence or tardiness;
- Unwillingness or inability to work in harmony with others;
- Discourtesy, irritation, friction, or other conduct that creates disharmony;
- Harassment or discrimination against another individual;
- Failure to be prepared for work by wearing the appropriate construction clothing or bringing the necessary tools; or
- Violation of any other commonly accepted reasonable rule of responsible personal conduct.

5.2 Disciplinary Actions

The Environmental Services (ES) business group employees, employees working on ES business group projects, and subcontractor employees are subject to disciplinary action for not following HSE rules and requirements. Potential disciplinary action is equally applicable to all employees including management and supervision. Disciplinary action may include denial of access to the worksite, warnings, reprimands, and other actions up to and including termination depending on the specific circumstances.

5.3 Subcontractor Safety Performance

CH2M HILL should continuously endeavor to observe subcontractors' safety performance and adherence to their plans and AHAs. This endeavor should be reasonable, and include observing for hazards or unsafe practices that are both readily observable and occur in common work areas. CH2M HILL is not responsible for exhaustive observation for hazards and unsafe practices. CH2M HILL oversight does not relieve subcontractors of their responsibility for effective implementation and compliance with the established plan(s).

5.3.1 Observed Hazard Form

When apparent non-compliance or unsafe conditions or practices are observed, notify the subcontractor's supervisor or safety representative verbally, and document using the Observed Hazard Form, included as an attachment to this HSP, and require corrective action.

If necessary, stop subcontractor's work using the Stop Work Order Form until corrective actions is implemented for observed serious hazards or conditions. Update the Observed Hazard Form to document corrective actions have been taken. The subcontractor is responsible for determining and implementing necessary controls and corrective actions.

5.3.2 Stop Work Order

CH2M HILL has the authority, as specified in the contract, and the responsibility to stop work in the event any CH2M HILL employee observes unsafe conditions or failure of the subcontractor to adhere to its safe-work practices. This authority and action does not in any way relieve the subcontractor of its responsibilities for the means and methods of the work or, therefore, of any corrective actions. Failure to comply with safe work practices can be the basis for restriction or removal of the subcontractor staff from the job site, termination of the subcontract, restriction from future work, or all three.

When an apparent imminent danger is observed, immediately stop work and alert all affected individuals. Remove all affected CH2M HILL employees and subcontractor staff from the danger, notify the subcontractor's supervisor or safety representative, and do not allow work to resume until adequate corrective measures are implemented. Notify the PM, Contract Administrator (KA) and RHSM.

When repeated non-compliance or unsafe conditions are observed, notify the subcontractor's supervisor or safety representative and stop affected work by completing and delivering the Stop Work Order Form (attached to this HSP) until adequate corrective measures are implemented. Consult the KA to determine what the contract dictates for actions to pursue in event of subcontractor non-compliance including work stoppage, back charges, progress payments, removal of subcontractor manager, monetary penalties, or termination of subcontractor for cause.

5.4 Incentive Program

Each project is encouraged to implement a safety incentive program that rewards workers for exhibiting exemplary safety behaviors. Actions that qualify are those that go above and beyond what is expected. Actions that will be rewarded include spotting and correcting a hazard, bringing a hazard to the attention of your foreman, telling your foreman about an incident, coming up with a safer way to get the work done, or stopping a crew member from doing something unsafe. The program will operate throughout the project, covering all workers. The incentive program will be communicated to all employees during the project employee orientation and project safety meetings.

5.5 Reporting Unsafe Conditions/Practices

Responsibility for effective health and safety management extends to all levels of the project and requires good communication between employees, supervisors, and management. Accident prevention requires a pro-active policy on near misses, close calls, unsafe conditions, and unsafe practices. All personnel must report any situation, practice, or condition which might jeopardize the safety of our projects. All unsafe conditions or unsafe practices will be corrected immediately. CH2M HILL has zero tolerance of unsafe conditions or unsafe practices.

No employee or supervisor will be disciplined for reporting unsafe conditions or practices. Individuals involved in reporting the unsafe conditions or practices will remain anonymous.

The following reporting procedures will be followed by all project employees:

- Upon detection of any unsafe condition or practice, the responsible employee will attempt to safely correct the condition;
- The unsafe condition or practice will be brought to the attention of the worker's direct supervisor, unless the unsafe condition or practice involves the employee's direct supervisor. If so, the SC needs to be notified at once by the responsible employee;

- Either the responsible employee or responsible employee's direct supervisor is responsible for immediately reporting the unsafe condition or practice to the SC;
- The SC will act promptly to correct the unsafe condition or practice; and
- Details of the incident or situation will be recorded by the SC in the field logbook or use the Observed Hazard Form if subcontractor was involved.

SECTION 6

Safety Planning and Change Management

6.1 Daily Safety Meetings and Pre-Task Safety Plans

Daily safety meetings are to be held with all project personnel in attendance to review the hazards posed and required HSE procedures and AHAs that apply for each day's project activities. The Pre-Task Safety Plans (PTSPs) serve the same purpose as these general assembly safety meetings, but the PTSPs are held between the crew supervisor and their work crews to focus on those hazards posed to individual work crews.

At the start of each day's activities, the crew supervisor completes the PTSP, provided as an attachment to this HSP, with input from the work crew, during their daily safety meeting. The day's tasks, personnel, tools and equipment that will be used to perform these tasks are listed, along with the hazards posed and required HSE procedures, as identified in the HSP and AHA. The use of PTSPs promotes worker participation in the hazard recognition and control process while reinforcing the task-specific hazard and required HSE procedures with the crew each day.

6.2 Change Management

This HSP addresses all known activities and associated hazards. As work progresses, if significant changes are identified which could affect health and safety at the site, coordinate with the RHSM to determine whether a HSP update is necessary.

The following are examples of changes that may require a revision to the plan:

- Change in CH2M HILL staff;
- New subcontractor to perform work;
- New chemicals brought to site for use;
- Change in scope or addition of new tasks;
- Change in contaminants of concern (COCs) or change in concentrations of COCs; and
- New hazards or hazards not previously identified that are not addressed in this HSP.

6.3 Agency Inspection Guidance

(Reference CH2M HILL SOP HSE-201, *Agency Inspections and Communications*)

Agency inspections (e.g., OSHA, EPA, other regulatory agencies) are on the rise. CH2M HILL implements safety and environmental programs in order to ensure safety to workers, the public, and the environment. This plan addresses things like labeling containers, completing the hazard communication training using the attachments to this HSP, listing training requirements and PPE requirements, and addressing project-specific hazards. Field personnel need to contact the RHSM to update this plan if hazards are encountered that are not addressed.

SOP HSE-201 addresses agency inspections in detail, and the attached **Target Zero Bulletin on Agency Inspections** provides a good summary of the inspection process and what to do if an agency such as OSHA or EPA shows up at the site. It is critical to make immediate notification to the RHSM if an inspector arrives (and EM if it is environmental-related); they can help facilitate and make additional notifications.

Review the Target Zero Bulletin and keep it with your Health and Safety Plan/Environmental Plan. Make it a topic at a safety meeting and keep it readily available in the event of an inspection.

SECTION 7

Project Hazard Analysis

A health and safety risk analysis (Table 1) has been performed for each task. In the order listed below, the RHSM considers the various methods for mitigating the hazards. Employees are trained on this hierarchy of controls during their hazardous waste training and reminded of them throughout the execution of projects:

- Elimination of the hazards (use remote sampling methodology to avoid going into a confined space);
- Substitution (reduce exposure to vapors by using of a geoprobe instead of test pitting);
- Engineering controls (ventilate a confined space to improve air quality);
- Warnings (establish exclusion zones to keep untrained people away from hazardous waste work);
- Administrative controls (implement a work-rest schedule to reduce chance of heat stress); or
- Use of PPE (use of respirators when action levels are exceeded).

The hazard controls and safe work practices are summarized in the following sections of this HSP:

- General hazards and controls;
- Project-specific hazards and controls;
- Physical hazards and controls;
- Biological hazards and controls; and
- Contaminants of concern

7.1 Activity Hazard Analysis

An AHA defines the activity being performed, the hazards posed and control measures required to perform the work safely. Workers are briefed on the AHA before doing the work and their input is solicited prior, during, and after the performance of work to further identify the hazards posed and control measures required. The AHA shall identify the work tasks required to perform each activity, along with potential HSE hazards and recommended control measures for each hazard. In addition, a listing of the equipment to be used to perform the activity, inspection requirements and training requirements for the safe operation of the equipment listed must be identified. The following hazard controls and applicable CH2M HILL core standards and SOPs should be used as a basis for preparing AHAs.

AHAs must be prepared for CH2M HILL activities and included as an attachment to this HSP.

7.2 Subcontractor Activity Hazard Analysis

CH2M HILL subcontractors are required to provide AHAs specific to their scope of work on the project for acceptance by CH2M HILL. Each subcontractor shall submit AHAs for their field activities, as defined in their scope of work, along with their project-specific safety plan and/or procedures. Additions or changes in field activities, equipment, tools, or material used to perform work or hazards not addressed in existing AHAs requires either a new AHA to be prepared or an existing AHA to be revised.

TABLE 1
General Activity Hazard Analysis

Potential Hazard	Drilling / Well Install	Pore testing / Sampling	Survey / Utility locate	IDW Mgmt.	Soil/ Sediment Sampling	Groundwater/ Surface Water Sampling
Biological Hazards	X	X	X	X	X	X
Cadmium	X	X		X	X	X
Chemical Hazard	X	X		X	X	X
Drilling	X					
Drum Handling				X		
Drum Sampling				X		
Electrical Safety		X	X			X
Field Vehicles	X	X	X	X	X	X
Fire Prevention	X	X	X	X	X	X
Groundwater Sampling		X				X
Hand & Power Tools	X	X	X	X	X	X
Knife Use	X	X				X
Manual Lifting	X	X	X	X	X	X
Noise	X					
Pressure Washing Equipment/ Decontamination	X					
Temperature Extremes	X	X	X	X	X	X
Traffic Control	X	X	X	X	X	X
Ultraviolet Light exposure (sunburn)	X	X	X	X	X	X
Utilities (underground/overhead)	X					
Visible Lighting	X	X	X	X	X	X

SECTION 8

General Hazards and Controls

8.1 General Practices and Housekeeping

The following are general requirements applicable to all portions of the work:

- Site work should be performed during daylight hours whenever possible;
- Good housekeeping must be maintained at all times in all project work areas;
- Common paths of travel should be established and kept free from the accumulation of materials;
- Keep access to aisles, exits, ladders, stairways, scaffolding, and emergency equipment free from obstructions;
- Provide slip-resistant surfaces, ropes, or other devices to be used;
- Specific areas should be designated for the proper storage of materials;
- Tools, equipment, materials, and supplies shall be stored in an orderly manner;
- As work progresses, scrap and unessential materials must be neatly stored or removed from the work area;
- Containers should be provided for collecting trash and other debris and shall be removed at regular intervals;
- All spills shall be quickly cleaned up; oil and grease shall be cleaned from walking and working surfaces;
- Review the safety requirements of each job you are assigned to with your supervisor. You are not expected to perform a job that may result in injury or illness to yourself or to others;
- Familiarize yourself with, understand, and follow jobsite emergency procedures;
- Do not fight or horseplay while conducting the firm’s business;
- Do not use or possess firearms or other weapons while conducting the firm’s business;
- Report unsafe conditions or unsafe acts to your supervisor immediately;
- Report emergencies, occupational illnesses, injuries, vehicle accidents, and near misses immediately;
- Do not remove or make ineffective safeguards or safety devices attached to any piece of equipment;
- Report unsafe equipment, defective or frayed electrical cords, and unguarded machinery to your supervisor;
- Shut down and lock out machinery and equipment before cleaning, adjustment, or repair. Do not lubricate or repair moving parts of machinery while the parts are in motion;
- Do not run in the workplace;
- When ascending or descending stairways, use the handrail and take one step at a time;
- Do not apply compressed air to any person or clothing;
- Do not wear steel taps or shoes with metal exposed to the sole at any CH2M HILL project location;
- Do not wear finger rings, loose clothing, wristwatches, and other loose accessories when within arm’s reach of moving machinery;
- Remove waste and debris from the workplace and dispose of in accordance with federal, state, and local regulations;
- Note the correct way to lift heavy objects (secure footing, firm grip, straight back, lift with legs), and get help if needed. Use mechanical lifting devices whenever possible; and

- Check the work area to determine what problems or hazards may exist.

8.2 Driving Safety

Follow the guidelines below when operating a vehicle:

- Refrain from using a cellular phone while driving. Pull off the road, put the vehicle in park and turn on flashers before talking on a cellular phone;
- Never operate a personal digital assistant (PDA), or other device with e-mail, internet, or text messaging function while driving a vehicle;
- Obey speed limits; be aware of blind spots or other hazards associated with low visibility. Practice defensive driving techniques, such as leaving plenty of room between your vehicle and the one ahead of you;
- Do no drive while drowsy. Drowsiness can occur at any time, but is most likely after 18 hours or more without sleep;
- Maintain focus on driving. Eating, drinking, smoking, adjusting controls can divert attention from the road. Take the time to park and perform these tasks when parked rather than while driving; and
- Ensure vehicle drivers are familiar with the safe operation of vehicles of the type and size to be operated. Large vehicles such as full size vans and pick-ups have different vision challenges and handling characteristics than smaller vehicles.

8.3 Personal Hygiene

Good hygiene is essential for personal health and to reduce the potential of cross-contamination when working on a hazardous waste site. Implement the following:

- Keep hands away from nose, mouth, and eyes during work;
- Keep areas of broken skin (chapped, burned, etc.) covered; and
- Wash hands with soap and water prior to eating, smoking, or applying cosmetics.

8.4 Bloodborne Pathogens

(Reference CH2M HILL SOP HSE-202, *Bloodborne Pathogens*)

Exposure to bloodborne pathogens may occur when rendering first aid or cardiopulmonary resuscitation (CPR), or when coming into contact with landfill waste or waste streams containing potentially infectious material (PIM).

Employees trained in first-aid/CPR or those exposed to PIM must complete CH2M HILL's 1-hour bloodborne pathogens computer-based training module annually. When performing first-aid/CPR the following shall apply:

- Observe universal precautions to prevent contact with blood or other PIMs. Where differentiation between body fluid types is difficult or impossible, consider all body fluids to be potentially infectious materials;
- Always wash your hands and face with soap and running water after contacting PIMs. If washing facilities are unavailable, use an antiseptic cleanser with clean paper towels or moist towelettes; and
- If necessary, decontaminate all potentially contaminated equipment and surfaces with chlorine bleach as soon as possible. Use one part chlorine bleach (5.25 percent sodium hypochlorite solution) diluted with 10 parts water for decontaminating equipment or surfaces after initially removing blood or other PIMs. Remove contaminated PPE as soon as possible before leaving a work area.

CH2M HILL will provide exposed employees with a confidential medical examination should an exposure to PIM occur. This examination includes the following procedures:

- Documenting the exposure;
- Testing the exposed employee's and the source individual's blood (with consent); and

- Administering post-exposure prophylaxis.

8.5 Workplace Hazard Material Information System (WHMIS)

(Reference CH2M HILL SOPs HSE-107, *Hazard Communication* and HSE-403, *Hazardous Material Handling*)

The hazard communication coordinator is to perform the following:

- Complete an inventory of chemicals brought on site by CH2M HILL using the chemical inventory form included as an attachment to this HSP;
- Confirm that an inventory of chemicals brought on site by CH2M HILL subcontractors is available;
- Request or confirm locations of material safety data sheets (MSDSs) from the client, contractors, and subcontractors for chemicals to which CH2M HILL employees potentially are exposed;
- Before or as the chemicals arrive on site, obtain an MSDS for each hazardous chemical;
- Label chemical containers with the identity of the chemical and with hazard warnings, and store properly;
- Give employees required chemical-specific training using the chemical-specific training form included as an attachment to this HSP; and
- Store all materials properly, giving consideration to compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions.

The following are general guidelines for storing chemicals and other hazardous materials:

- Keep acids away from bases;
- Keep oxidizers (nitric acid, nitrates, peroxides, chlorates) and organics away from inorganic reducing agents (metals);
- Keep flammables and corrosives in appropriate storage cabinets;
- Do not store paper or other combustibles near flammables;
- Use secondary containment and lipped shelving that is secured; and
- Have a fire suppression system available.

8.6 Substance Abuse

(Reference CH2M HILL SOP HSE-105, *Drug-Free Workplace*)

Employees who work under the influence of controlled substances, drugs, or alcohol may prove to be dangerous or otherwise harmful to themselves, other employees, clients, the company, the company's assets and interests, or the public. CH2M HILL does not tolerate illegal drug use, or any use of drugs, controlled substances, or alcohol that impairs an employee's work performance or behavior.

Prohibitions onsite include:

- Use or possession of intoxicating beverages while performing CH2M HILL work;
- Abuse of prescription or nonprescription drugs;
- Use or possession of illegal drugs or drugs obtained illegally;
- Sale, purchase, or transfer of legal, illegal or illegally obtained drugs; and
- Arrival at work under the influence of legal or illegal drugs or alcohol.

Drug and/or alcohol testing is applicable under CH2M HILL Constructors, Inc. and munitions response projects performed in the United States. In addition, employees may be required to submit to drug and/or alcohol testing as required by clients. When required, this testing is performed in accordance with SOP HSE-105, Drug-Free

Workplace. Employees who are enrolled in drug or alcohol testing are required to complete annual training located on the CH2M HILL Virtual Office (VO).

8.7 Shipping and Transportation of Chemical Products

(Reference CH2M HILL's Procedures for Shipping and Transporting Dangerous Goods)

Chemicals brought to the site might be defined as hazardous materials by the U.S. Department of Transportation (DOT). All staff who ship the materials or transport them by road must receive CH2M HILL training in shipping dangerous goods. All hazardous materials that are shipped (e.g., via Federal Express) or are transported by road must be properly identified, labeled, packed, and documented by trained staff. Contact the RHSM or the Warehouse Coordinator for additional information.

8.8 Site Sanitation Plan

The requirements of EM 385 1-1, 02.E.01 do not apply to mobile crews or to normally unattended work locations if employees working at these locations have transportation readily available to nearby toilet and/or washing facilities which meet the other requirements of section 02.E.01.

However, in the event the project team provides a temporary sanitary facility at the project event for short duration field events, the toilet facilities shall be of the pre-manufactured, temporary/portable type chemical toilets typical of construction program and shall be constructed so the occupants are protected against weather (protection from falling objects is not applicable), with all cracks sealed, have a door that shall be tight-fitting, self-closing, and capable of being latched. Adequate ventilation (natural via vents) shall be provided and all windows and vents shall be screened. Toilet facilities shall be lighted via natural lighting.

Provisions for routinely servicing and cleaning all toilets and disposing of the sewage shall be established before placing toilet facilities into operation. The method of sewage disposal shall be managed by the temporary/portable toilet vendor. Separate toilet rooms for each sex need not be provided if toilet rooms can only be occupied by one person at a time can be locked from the inside, and contain at least one toilet seat.

Washing facilities shall be provided within or adjacent to the temporary/portable type chemical toilet facilities and as needed to maintain healthful and sanitary conditions. Each washing facility shall be maintained in a sanitary condition and provided with tepid water, suitable for hand washing, soap, and individual means of drying. If it is not practical to provide a water source for hand washing due to low ambient air temperatures (~32ºF) running water, then hand sanitizers may be used as a substitute. Washing facilities shall be on the project work site.

Trash and garbage generated by the normal site operations must be properly stowed, containerized, and secured such that vermin will not be attracted and disposed of off-site on a regular basis.

At no time shall waste or trash generated during site operations be disposed of in NSY trash or garbage containers.

SECTION 9

Project-Specific Hazard Controls

This section provides safe work practices and control measures used to reduce or eliminate potential hazards. These practices and controls are to be implemented by the party in control of either the work or the particular hazard. Each person onsite is required to abide by the hazard controls. Consult the appropriate CH2M HILL SOP to ensure all requirements are implemented. CH2M HILL employees and subcontractors must remain aware of the hazards affecting them regardless of who is responsible for controlling the hazards. CH2M HILL employees and subcontractors who do not understand any of these provisions should contact the RHSM for clarification.

9.1 Cadmium

(Reference CH2M HILL SOP HSE-504, *Cadmium*)

Cadmium is considered a "Suspected Human Carcinogen." CH2M HILL is required to control employee workplace exposure to cadmium when personal exposure is at or above 2.5 micrograms per cubic meter ($\mu g/m^3$) by implementing a program that meets the requirements of the OSHA Cadmium standard, 29 *Code of Federal Regulations* (CFR) 1926.1127. The elements of the CH2M HILL cadmium program include the following:

- Exposure monitoring;
- Methods of control, including PPE and respirators;
- Medical surveillance;
- Training on hazards of cadmium and control measures (includes project-specific training and the computer-based training on CH2M HILL's Virtual Office, *Cadmium);* and
- Recordkeeping requirements.

If air monitoring indicates there is potential exposure at the action level concentrations above, notify the RHSM to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas;
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person; and
- Review the fact sheet included as an attachment to this HSP.

9.2 Drilling Safety

(Reference CH2M HILL SOP HSE-204, *Drilling*)

Below are the hazard controls and safe work practices to follow when working around or performing drilling. Ensure the requirements in the referenced SOP are followed.

- The drill rig is not to be operated in inclement weather.
- The driller is to verify that the rig is properly leveled and stabilized before raising the mast.
- Personnel should be cleared from the sides and rear of the rig before the mast is raised.
- The driller is not to drive the rig with the mast in the raised position.

- The driller must check for overhead power lines before raising the mast. A minimum distance of 10 feet (3 meters) between mast and overhead lines (<50 kV) is recommended. Increased separation may be required for lines greater than 50 kV.
- Personnel should stand clear before rig startup.
- The driller is to verify that the rig is in neutral when the operator is not at the controls.
- Become familiar with the hazards associated with the drilling method used (cable tool, air rotary, hollow-stem auger, etc.).
- Do not wear loose-fitting clothing, watches, etc., that could get caught in moving parts.
- Do not smoke or permit other spark-producing equipment around the drill rig.
- The drill rig must be equipped with a kill wire or switch, and personnel are to be informed of its location.
- Be aware and stand clear of heavy objects that are hoisted overhead.
- The driller is to verify that the rig is properly maintained in accordance with the drilling company's maintenance program.
- The driller is to verify that all machine guards are in place while the rig is in operation.
- The driller is responsible for housekeeping (maintaining a clean work area).
- The drill rig should be equipped with at least one fire extinguisher.
- If the drill rig comes into contact with electrical wires and becomes electrically energized, do not touch any part of the rig or any person in contact with the rig, and stay as far away as possible. Notify emergency personnel immediately.
- Use the drilling self-assessment checklist attached to this HSP to evaluate drilling operations.

9.3 Drum Handling

Below are the hazard controls and safe work practices to follow when overseeing the movement of drums or when handling drums.

- Ensure that personnel are trained in proper lifting and moving techniques to prevent back injuries.
- Ensure drum bungs/lids are secured and drums are labeled prior to moving.
- Provide equipment to keep the operator removed from the drums to lessen the likelihood of injury. Such equipment might include: a drum grappler attached to a hydraulic excavator; a small front-end loader, which can be either loaded manually or equipped with a bucket sling; a rough terrain forklift; Roller conveyor equipped with solid rollers; drum carts designed specifically for drum handling.
- Make sure the vehicle selected has sufficient rated load capacity to handle the anticipated loads, and make sure the vehicle can operate smoothly on the available road surface.
- Ensure there are appropriately designed Plexiglas cab shields on loaders, backhoes, etc., when handling drums containing potentially explosive materials.
- Equipment cabs should be supplied with fire extinguishers, and should be air-conditioned to increase operator efficiency.
- Supply operators with appropriate respiratory protective equipment when needed.
- Ensure that drums are secure and are not in the operator's view of the roadway.
- Prior to handling, all personnel should be warned about hazards of handling.

- Before moving anything, determine the most appropriate sequence in which the various drums and other containers should be moved (e.g. small containers may have to be removed first to permit heavy equipment to enter and move the drums.
- Overpack drums and an adequate volume of absorbent should be kept near areas where minor spills may occur.

9.4 Drum Sampling Safety

Personnel are permitted to handle and/or sample drums containing certain types of waste (drilling waste, investigation-derived waste, and waste from known sources) only. Handling or sampling drums with unknown contents requires a plan revision or amendment approved by the RHSM. The following control measures will be taken when sampling drums:

- Minimize transportation of drums.
- Sample only labeled drums or drums from a known waste stream.
- Do not sample bulging or swollen drums. Contact the RHSM.
- If drums contain, or potentially contain, flammable materials, use non-sparking tools to open.
- Use the proper tools to open and seal drums.
- Reseal bung holes or plugs whenever possible.
- Avoid mixing incompatible drum contents.
- Sample drums without leaning over the drum opening.
- Transfer/sample the content of drums using a method that minimizes contact with material.
- Use the PPE and perform air monitoring as specified in the PPE and Site Monitoring sections of this HSP.
- Have a spill kit accessible during sampling activities.
- If transferring/sampling drums containing flammable or combustible liquids, drums and liquid transfer equipment should be grounded and bonded to reduce the potential of a static discharge.

9.5 Soil/Sediment Sampling

Below are the hazard controls and safe work practices to follow when conducting soil or sediment sampling.

- Observe proper lifting techniques.
- Obey sensible lifting limits (60 lb maximum per person manual lifting). Follow SAP. Ask for assistance if there is any concern. Use mechanical lifting equipment to move large, awkward loads.
- No excavation until avoidance tech has cleared the excavation location and don’t excavate past the depth to which the tech has cleared
- Daily inspection of DPT rig & equipment
- Ensure appropriate guards are installed or suitable barriers to forewarn personnel of dangers
- Personnel clear during set up, clear of Probe Foot and Advancing Tooling
- Loose clothing to be safely secured
- Keep Hands Clear of Pinch Points
- Kill switch installed, clearly identified and operational
- Pressurized lines and hoses secured from whipping hazards

- Smoking prohibited around drilling area
- Good housekeeping on and about the rig
- Lockout/tagout procedures used prior to maintenance
- Dispose of cuttings and purge water properly
- DPT rig not to be operated in severe inclement weather such as lightning storms, high winds, or severe rain.
- Suppress dust where needed
- Air monitoring conducted per project's written safety plan for hazardous atmospheres
- Ventilation used to control hazardous atmospheres and air tested frequently
- Appropriate respiratory protection used when ventilation does not adequately control hazards
- Lift equipment and materials in a proper position
- Ensure that the direct push rig is on stable ground and that rig emergency brake is set and wheel chock is installed

9.6 Groundwater/Surface Water Sampling

- Keep exposed skin covered or use sun block, drink plenty of water.
- Be mindful of slippery surfaces
- Wear appropriate clothing. Wear long sleeved shirts, long pants.
- Use caution opening well, wear bug spray.
- Know the limitations of all hand tools. Use socket wrench, and if necessary bolt cutters to remove old, rusty locks.
- Allow well to vent, if readings continue over 5ppm then recap and advise management.
- Avoid shock from car battery power source. Make sure system is grounded.
- Use safe lifting practices.
- Be aware of hands as pump is lowered and recoiled, don't allow pumphead to fly out of well.
- Be careful about spilled water from pump discharge.
- Use proper cutting techniques when preparing discharge hose.
- Use caution when handling sample bottles containing preservatives. Hold sample containers away from face when filling and wear proper PPE. Use nitrile gloves. Bring eye wash bottles.
- For surface water sampling assess the easiest path to sample location, wear personal flotation device, and have a lifeline ready
- Read Tick & Poison Oak "Fact Sheets" attached to the Site Specific Health and Safety Plan
- Utilize insecticide with Deet to eliminate mosquito bites, West Nile Virus and Lyme Disease.

9.7 Electrical Safety

(Reference CH2M HILL SOP HSE-206, *Electrical Safety*)

Below are the hazard controls and safe work practices to follow when using electrical tools, extension cords, and/or other electrical-powered equipment or when exposed to electrical hazards. Ensure the requirements of the referenced SOP are followed.

9.7.1 General Electrical Safety

- Only qualified personnel are permitted to work on unprotected energized electrical systems.
- Only authorized personnel are permitted to enter high-voltage areas.
- CH2M HILL employees who might from time to time work in an environment influenced by the presence of electrical energy must complete Awareness Level Electrical Safety Training located on the CH2M HILL Virtual Office.
- Do not tamper with electrical wiring and equipment unless qualified to do so. All electrical wiring and equipment must be considered energized until lockout/tagout procedures are implemented.
- Inspect electrical equipment, power tools, and extension cords for damage prior to use. Do not use defective electrical equipment, remove from service.
- CH2M HILL has selected Ground Fault Circuit Interrupters (GFCIs) as the standard method for protecting employees from the hazards associated with electric shock.
- GFCIs shall be used on all 120-volt, single phase 15 and 20-amphere receptacle outlets which are not part of the permanent wiring of the building or structure.
- An assured equipment grounding conductor program may be required under the following scenarios:
  - GFCIs cannot be utilized;
  - Client requires such a program to be implemented; or
  - Business group decides to implement program in addition to GFCI protection.
- Extension cords must be equipped with third-wire grounding. Cords passing through work areas must be covered, elevated or protected from damage. Cords should not be routed through doorways unless protected from pinching. Cords should not be fastened with staples, hung from nails, or suspended with wire.
- Electrical power tools and equipment must be effectively grounded or double-insulated and Underwriters Laboratory (UL) approved.
- Operate and maintain electric power tools and equipment according to manufacturers' instructions.
- Maintain safe clearance distances between overhead power lines and any electrical conducting material unless the power lines have been de-energized and grounded, or where insulating barriers have been installed to prevent physical contact. Maintain at least 10 feet (3 meters) from overhead power lines for voltages of 50 kV or less, and 10 feet (3 meters) plus ½ inch (1.27 cm) (for every 1 kV over 50 kV.
- Temporary lights shall not be suspended by their electric cord unless designed for suspension. Lights shall be protected from accidental contact or breakage.
- Protect all electrical equipment, tools, switches, and outlets from environmental elements.

9.7.2 Portable Generator Hazards

- Portable generators are useful when temporary or remote electric power is needed, but they also can be hazardous. The primary hazards to avoid when using a generator are carbon monoxide (CO) poisoning from the toxic engine exhaust, electric shock or electrocution, and fire.

- NEVER use a generator indoors or in similar enclosed or partially-enclosed spaces. Generators can produce high levels of carbon monoxide (CO) very quickly. When you use a portable generator, remember that you cannot smell or see CO. Even if you can't smell exhaust fumes, you may still be exposed to CO.
- If you start to feel sick, dizzy, or weak while using a generator, get to fresh air RIGHT AWAY. DO NOT DELAY. The CO from generators can rapidly lead to full incapacitation and death.
- If you experience serious symptoms, get medical attention immediately. Inform project staff that CO poisoning is suspected. If you experienced symptoms while indoors have someone call the fire department to determine when it is safe to re-enter the building.
- Follow the instructions that come with your generator. Locate the unit outdoors and away from doors, windows, and vents that could allow CO to come indoors.
- Keep the generator dry and do not use in rain or wet conditions. To protect from moisture, operate it on a dry surface under an open, canopy-like structure. Dry your hands if wet before touching the generator.
- Plug appliances directly into the generator. Or, use a heavy duty, outdoor-rated extension cord that is rated (in watts or amps) at least equal to the sum of the connected appliance loads. Check that the entire cord is free of cuts or tears and that the plug has all three prongs, especially a grounding pin.
- Most generators come with Ground Fault Circuit Interrupters (GFCI). Test the GFCIs daily to determine whether they are working
- If the generator is not equipped with GFCI protected circuits plug a portable GFCI into the generator and plug appliances, tools and lights into the portable GFCI.
- Never store fuel near the generator or near any sources of ignition.
- Before refueling the generator, turn it off and let it cool down. Gasoline spilled on hot engine parts could ignite.

9.8 Field Vehicles

- Field vehicles may be personal vehicles, rental vehicles, fleet vehicles, or project vehicles.
- Maintain a first aid kit, bloodborne pathogen kit, and fire extinguisher in the field vehicle at all times.
- Utilize a rotary beacon on vehicle if working adjacent to active roadway.
- Car rental must meet the following requirements:
  - Dual air bags
  - Antilock brakes
  - Be midsize or larger
- Familiarize yourself with rental vehicle features prior to operating the vehicle:
  - Vision Fields and Blind Spots
  - Vehicle Size
  - Mirror adjustments
  - Seat adjustments
  - Cruise control features, if offered
  - Pre-program radio stations and Global Positioning System (GPS), if equipped
- Always wear seatbelt while operating vehicle.
- Adjust headrest to proper position.
- Tie down loose items if utilizing a van or pick-up truck.
- Close car doors slowly and carefully. Fingers can get pinched in doors.

- Park vehicle in a location where it can be accessed easily in the event of an emergency. If not possible, carry a phone.
- Have a designated place for storing the field vehicle keys when not in use.
- Ensure back-up alarms are functioning, if equipped. Before backing a vehicle, take a walk around the vehicle to identify obstructions or hazards. Use a spotter when necessary to back into or out of an area.

9.9 Fire Prevention

(Reference CH2M HILL SOP HSE-403, *Hazardous Material Handling*)

Follow the fire prevention and control procedures listed below.

9.9.1 Fire Extinguishers and General Fire Prevention Practices

- Fire extinguishers shall be provided so that the travel distance from any work area to the nearest extinguisher is less than 100 feet (30.5 meters). When 5 gallons (19 liters) or more of a flammable or combustible liquid is being used, an extinguisher must be within 50 feet (15.2 meters). Extinguishers must:
  - be maintained in a fully charged and operable condition;
  - be visually inspected each month; and
  - undergo a maintenance check each year.
- The area in front of extinguishers must be kept clear.
- Post “Exit” signs over exiting doors, and post “Fire Extinguisher” signs over extinguisher locations.
- Combustible materials stored outside should be at least 10 feet (3 meters) from any building.
- Solvent waste and oily rags must be kept in a fire resistant, covered container until removed from the site.

9.9.2 Storage of Flammable/Combustible Liquids

- Only approved containers and portable tanks shall be used for storage and handling of flammable and combustible liquids.
- Approved safety cans shall be used for the handling and use of flammable liquids in quantities of 5 gallons (22.7 liters) or less. Do not use plastic gas cans.
- For quantities of 1 gallon (4.5 liters) or less, the original container may be used for storage and use of flammable liquids.
- Flammable or combustible liquids shall not be stored in areas used for stairways or normally used for the passage of people.

9.9.3 Indoor Storage of Flammable/Combustible Liquids

- No more than 25 gallons (113.7 liters) of flammable or combustible liquids shall be stored in a room outside of an approved storage cabinet.
- Quantities of flammable and combustible liquids in excess of 25 gallons (113.7 liters) shall be stored in an acceptable or approved cabinet.
- Cabinets shall be conspicuously lettered: "FLAMMABLE: KEEP FIRE AWAY."
- Not more than 60 gallons (272.8 liters) of flammable or 120 gallons (545.5 liters) of combustible liquids shall be stored in any one storage cabinet. Not more than three such cabinets may be located in a single storage area.

9.9.4 Outside Storage of Flammable/Combustible Liquids

- Storage of containers (not more than 60 gallons [272.8 liters] each) shall not exceed 1,100 gallons (5000 liters) in any one area. No area shall be within 20 feet (6.1 meters) of any building.
- Storage areas shall be graded to divert spills away from buildings and surrounded by an earthen dike.
- Storage areas shall be free from weeds, debris, and other combustible materials.
- Outdoor portable tanks shall be provided with emergency vent devices and shall not be closer than 20 feet (6.1 meters) to any building.
- Signs indicating no smoking shall be posted around the storage area.

9.9.5 Dispensing of Flammable/Combustible Liquids

- Areas in which flammable or combustible liquids are dispensed in quantities greater than 5 gallons (22.7 liters) (shall be separated from other operations by at least 25 feet (7.6 meters).
- Drainage or other means shall be provided to control spills.
- Adequate natural or mechanical ventilation shall be provided to maintain the concentration of flammable vapor at or below 10 percent of the lower flammable limit.
- Dispensing of flammable liquids from one container to another shall be done only when containers are electrically interconnected (bonded).
- Dispensing flammable or combustible liquids by means of air pressure on the container or portable tanks is prohibited.
- Dispensing devices and nozzles for flammable liquids shall be of an approved type.

9.10 Groundwater Sampling/Water Level Measurements

Below are the hazard controls and safe work practices to follow when personnel or subcontractors are performing groundwater sampling and/or water level measurements.

- Full coolers are heavy. Plan in advance to have two people available at the end of the sampling effort to load full coolers into vehicles. If two people won’t be available use several smaller coolers instead of fewer large ones.
- Wear the appropriate PPE when sampling, including safety glasses, nitrile gloves, and steel toe boots (see PPE section of this HSP).
- Monitor headspace of wells prior to sampling to minimize any vapor inhalation (refer to the “Site Monitoring” section of this HSP).
- Use caution when opening well lids. Wells may contain poisonous spiders and hornet or wasp nests.
- Use the appropriate lifting procedures (see CH2M HILL SOP HSE-112) when unloading equipment and sampling at each well.
- Avoid sharp edges on well casings.
- If dermal contact occurs with groundwater or the acid used in sample preservation, immediately wash all affected skin thoroughly with soap and water.
- Avoid eating and drinking on site and during sampling.
- Use ear plugs during sampling if sampling involves a generator.
- Containerize all purge water and transport to the appropriate storage area.

- Use two people to transport full coolers/containers whenever possible. If two people are not available use a dolly to move coolers. If the coolers weigh more than 40 pounds Attachment 1 of the HSE-112, *Manual Lifting,* shall be completed by the SC. If the coolers weigh more than 50 pounds they should never be lifted by one person.

9.11 Hand and Power Tools

(Reference CH2M HILL, SOP HSE-210, *Hand and Power Tools*)

Below are the hazard controls and safe work practices to follow when personnel or subcontractors are using hand and power tools. Ensure the requirements in the referenced SOP are followed.

- Tools shall be inspected prior to use and damaged tools will be tagged and removed from service.
- Hand tools will be used for their intended use and operated in accordance with manufacturer's instructions and design limitations;
- Maintain all hand and power tools in a safe condition.
- Use PPE (such as gloves, safety glasses, earplugs, and face shields) when exposed to a hazard from a tool.
- Do not carry or lower a power tool by its cord or hose.
- Portable power tools will be plugged into GFCI protected outlets; and
- Portable power tools will be Underwriters Laboratories (UL) listed and have a three-wire grounded plug or be double insulated.
- Disconnect tools from energy sources when they are not in use, before servicing and cleaning them, and when changing accessories (such as blades, bits, and cutters).
- Safety guards on tools must remain installed while the tool is in use and must be promptly replaced after repair or maintenance has been performed.
- Store tools properly in a place where they will not be damaged or come in contact with hazardous materials.
- If a cordless tool is connected to its recharge unit, both pieces of equipment must conform strictly with electrical standards and manufacturer's specifications.
- Tools used in an explosive environment must be rated for work in that environment (that is, intrinsically safe, spark-proof, etc.).
- Working with manual and pistol-grip hand tools may involve highly repetitive movement, extended elevation, constrained postures, and/or awkward positioning of body members (for example, hand, wrist, arm, shoulder, neck, etc.). Consider alternative tool designs, improved posture, the selection of appropriate materials, changing work organization, and sequencing to prevent muscular, skeletal, repetitive motion, and cumulative trauma stressors.

Machine Guarding

- Ensure that all machine guards are in place to prevent contact with drive lines, belts, chains, pinch points or any other sources of mechanical injury.
- Unplugging jammed equipment will only be performed when equipment has been shut down, all sources of energy have been isolated and equipment has been locked/tagged and tested.
- Maintenance and repair of equipment that results in the removal of guards or would otherwise put anyone at risk requires lockout of that equipment prior to work.

9.12 Knife Use

Open-bladed knives (for example, box cutters, utility knives, pocket knives, machetes, and multi-purpose tools with fixed blades such as a Leatherman™) are prohibited at worksites except where the following three conditions are met:

- The open-bladed knife is determined to be the best tool for the job;
- An approved Activity Hazard Analysis (AHA) or written procedure is in place that covers the necessary safety precautions (work practices, PPE, and training); and
- Knife users have been trained and follow the AHA.

9.13 Manual Lifting

(Reference CH2M HILL SOP HSE-112, *Manual Lifting*)

Back injuries are the leading cause of disabling work and most back injuries are the result of improper lifting techniques or overexertion. Use the following to mitigate the hazards associated with lifting:

- When possible, the task should be modified to minimize manual lifting hazards;
- Lifting of loads weighing more than 40 pounds (18 kilograms) shall be evaluated by the SC using the Lifting Evaluation Form contained in SOP HSE-112;
- Using mechanical lifting devices is the preferred means of lifting heavy objects such as forklifts; cranes, hoists, and rigging; hand trucks; and trolleys;
- Personnel shall seek assistance when performing manual lifting tasks that appear beyond their physical capabilities;
- In general, the following steps must be practiced when planning and performing manual lifts: Assess the situation before you lift; ensure good lifting and body positioning practices; ensure good carrying and setting down practices; and
- All CH2M HILL workers must have training in proper manual lifting training either through the New Employee Orientation or through Manual Lifting module located on the VO.

9.14 Pressure Washing Operations

Below are the hazard controls and safe work practices to follow when working around or performing pressure washing.

- Only trained, authorized personnel may operate the high-pressure washer.
- Follow manufacturer’s safety and operating instructions.
- Inspect pressure washer before use and confirm deadman trigger is fully operational
- The wand must always be pointed at the work area.
- The trigger should never be tied down
- Never point the wand at yourself or another worker.
- The wand must be at least 42 inches (1.1 meter) from the trigger to the tip and utilize greater than 10 degree tips.
- The operator must maintain good footing.
- Non-operators must remain a safe distance from the operator.
- No unauthorized attachment may be made to the unit.

- Do not modify the wand.
- All leaks or malfunctioning equipment must be repaired immediately or the unit taken out-of-service.
- Polycoated Tyvek or equivalent, 16-inch-high steel-toed rubber boots, safety glasses, hard hat with face shield, and inner and outer nitrile gloves will be worn, at a minimum.

9.15 Traffic Control

(Reference CH2M HILL SOP HSE-216, *Traffic Control*)

The following precautions must be taken when working around traffic, and in or near an area where traffic controls have been established by a sub contractor. Ensure the requirements in the referenced SOP are followed.

- Exercise caution when exiting traveled way or parking along street – avoid sudden stops, use flashers, etc.
- Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier.
- All staff working adjacent to traveled way or within work area must wear reflective/high-visibility safety vests.
- Eye protection should be worn to protect from flying debris.
- Remain aware of factors that influence traffic related hazards and required controls – sun glare, rain, wind, flash flooding, limited sight-distance, hills, curves, guardrails, width of shoulder (i.e., breakdown lane), etc.
- Always remain aware of an escape route (e.g., behind an established barrier, parked vehicle, guardrail, etc).
- Always pay attention to moving traffic – never assume drivers are looking out for you.
- Work as far from traveled way as possible to avoid creating confusion for drivers.
- When workers must face away from traffic, a “buddy system” should be used, where one worker is looking towards traffic.
- When working on highway projects, obtain a copy of the contractor’s traffic control plan.
- Work area should be protected by a physical barrier – such as a K-rail or Jersey barrier.
- Review traffic control devices to ensure that they are adequate to protect your work area. Traffic control devices should: 1) convey a clear meaning, 2) command respect of road users, and 3) give adequate time for proper traffic response. The adequacy of these devices are dependent on limited sight distance, proximity to ramps or intersections, restrictive width, duration of job, and traffic volume, speed, and proximity.
- Either a barrier or shadow vehicle should be positioned a considerable distance ahead of the work area. The vehicle should be equipped with a flashing arrow sign and truck-mounted crash cushion (TMCC). All vehicles within 40 feet (12.2 meters) of traffic should have an orange flashing hazard light atop the vehicle.
- Except on highways, flaggers should be used when 1) two-way traffic is reduced to using one common lane, 2) driver visibility is impaired or limited, 3) project vehicles enter or exit traffic in an unexpected manner, or 4) the use of a flagger enhances established traffic warning systems.
- Lookouts should be used when physical barriers are not available or practical. The lookout continually watches approaching traffic for signs of erratic driver behavior and warns workers.
- Vehicles should be parked at least 40 feet (12.2 meters) away from the work zone and traffic. Minimize the amount of time that you will have your back to oncoming traffic.
- Traffic control training module on the VO shall be completed when CH2M HILL workers who work in and around roadways and who exposed to public vehicular traffic.

9.16 Utilities (underground)

An assessment for underground utilities must be conducted where there is a potential to contact underground utilities or similar subsurface obstructions during intrusive activities. Intrusive activities include excavation, trenching, drilling, hand augering, soil sampling, or similar activities.

The assessment must be conducted before any intrusive subsurface activity and must include at least the following elements:

1. A background and records assessment of known utilities or other subsurface obstructions.
2. Contacting and using the designated local utility locating service.
3. Conducting an independent field survey to identify, locate, and mark potential underground utilities or subsurface obstructions. *Note: This is independent of, and in addition to, any utility survey conducted by the designated local utility locating service above.*
4. A visual survey of the area to validate the chosen location.

When any of these steps identifies an underground utility within 5 feet (1.5 meters) of intrusive work, then non-aggressive means must be used to physically locate the utility before a drill rig, backhoe, excavator or other aggressive method is used.

Aggressive methods are never allowed within 2 feet of an identified high risk utility (see paragraph below).

Any deviation from these requirements must be approved by the Responsible HS Manager and the Project Manager.

Background and Records Assessment of Known Utilities

Identify any client- or location-specific permit and/or procedural requirements (e.g., dig permit or intrusive work permit) for subsurface activities. For military installations, contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.

Obtain available utility diagrams and/or as-built drawings for the facility.

Review locations of possible subsurface utilities including sanitary and storm sewers, electrical lines, water supply lines, natural gas lines, fuel tanks and lines, communication lines, lighting protection systems, etc. Note: Use caution in relying on as-built drawings as they are rarely 100 percent accurate.

Request that a facility contact with knowledge of utility locations review and approve proposed locations of intrusive work.

Designated Local Utility Locating Service

Contact your designated local utility locating service (e.g., Dig-Safe, Blue Stake, One Call) to identify and mark the location of utilities. Call 811 in the US or go to www.call811.com to identify the appropriate local service group. Contacting the local utility locating service is a legal requirement in most jurisdictions.

Independent Field Survey (Utility Locate)

The organization conducting the intrusive work (CH2M HILL or subcontractor) shall arrange for an independent field survey to identify, locate, and mark any potential subsurface utilities in the work area. This survey is in addition to any utility survey conducted by the designated local utility locating service.

The independent field survey provider shall determine the most appropriate instrumentation/ technique or combinations of instrumentation/techniques to identify subsurface utilities based on their experience and expertise, types of utilities anticipated to be present, and specific site conditions.

A CH2M HILL or subcontractor representative must be present during the independent field survey to observe the utility locate and verify that the work area and utilities have been properly identified and marked. If there is any question that the survey was not performed adequately or the individual was not qualified, then arrangements must be made to obtain a qualified utility locate service to re-survey the area. Obtain documentation of the survey and clearances in writing and signed by the party conducting the clearance. Maintain all documentation in the project file.

If the site owner (military installation or client) can provide the independent field survey, CH2M HILL or the subcontractor shall ensure that the survey includes:

- Physically walking the area to verify the work location and identify, locate, and mark underground utility locations:
- Having qualified staff available and instrumentation to conduct the locate;
- Agreeing to document the survey and clearances in writing.
- Should any of the above criteria not be met, CH2M HILL or subcontractor must arrange for an alternate independent utility locate service to perform the survey.
- The markings from utility surveys must be protected and preserved until the markings are no longer required. If the utility location markings are destroyed or removed before intrusive work commences or is completed, the PM, SC, or designee must notify the independent utility locate service or the designated local utility locating service to resurvey and remark the area.

Visual Assessment before and during Intrusive Activities

Perform a “360 degree” assessment. Walk the area and inspect for utility-related items such as valve caps, previous linear cuts, patchwork in pavement, hydrants, manholes, utility vaults, drains, and vent risers in and around the dig area.

The visual survey shall include all surface landmarks, including manholes, previous liner cuts, patchwork in pavement, pad-mounted transformers, utility poles with risers, storm sewer drains, utility vaults, and fire hydrants.

If any unanticipated items are found, conduct further research before initiating intrusive activities and implement any actions needed to avoid striking the utility or obstruction.

Subsurface Activities within 5 feet of an Underground Utility or if there is Uncertainty

When aggressive intrusive activities will be conducted within 5 feet (1.5 meters) of an underground utility or when there is uncertainty about utility locations, locations must be physically verified by non-aggressive means such as air or water knifing, hand digging, or human powered hand augering. Non-conductive tools must be used if electrical hazards may be present. If intrusive activities are within 5 feet (1.5 meters) and parallel to a marked existing utility, the utility location must be exposed and verified by non-aggressive methods every 100 feet (30.5 meters). Check to see if the utility can be isolated during intrusive work.

Intrusive Activities within 2 feet of an Underground Utility

Use non-aggressive methods (hand digging, vacuum excavation, etc.) to perform intrusive activities within 2 feet of a high risk utility (i.e., a utility that cannot be de-energized or would cause significant impacts to repair/replace). Hazardous utilities shall be de-energized whenever possible.

Spotter

A spotter shall be used to monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon, presence of pea gravel or sand in soils, presence of concrete or other debris in soils, refusal of auger or excavating equipment). If any suspicious conditions are encountered stop work immediately and contact the PM or RHSM to evaluate the situation. The spotter must have a method to alert an operator to stop the intrusive activity (e.g., air horn, hand signals).

9.17 Utilities (overhead)

Proximity to Power Lines

No work is to be conducted within 50 feet (15.2 meters) of overhead power lines without first contacting the utility company to determine the voltage of the system. No aspect of any piece of equipment is to be operated within 50 feet (15.2 meters) of overhead power lines without first making this determination.

Operations adjacent to overhead power lines are PROHIBITED unless one of the following conditions is satisfied:

- Power has been shut off, positive means (such as lockout) have been taken to prevent the lines from being energized, lines have been tested to confirm the outage, and the utility company has provided a signed certification of the outage.
- The minimum clearance from energized overhead lines is as shown in the table below, or the equipment will be repositioned and blocked to ensure that no part, including cables, can come within the minimum clearances shown in the table.

MINIMUM DISTANCES FROM POWERLINES

Powerlines Nominal System Kv	Minimum Required Distance, Feet (Meters)
0-50	10 (3.0)
51-100	12 (3.7)
101-200	15 (4.6)
201-300	20 (6.1)
301-500	25 (7.6)
501-750	35 (10.7)
751-1000	45 (13.7)

(These distances have been determined to eliminate the potential for arcing based on the line voltage.)

- The power line(s) has been isolated through the use of insulating blankets which have been properly placed by the utility. If insulating blankets are used, the utility will determine the minimum safe operating distance; get this determination in writing with the utility representative's signature.
- All inquiries regarding electric utilities must be made in writing and a written confirmation of the outage/isolation must be received by the PM prior to the start of work.

9.18 Visible Lighting

Lighting shall be evaluated when conducting work inside buildings, confined spaces, or other areas/instances where supplemental light may be needed (e.g., work before sunrise or after sunset). A light meter can be used to evaluate the adequacy of lighting. The following are common requirements for lighting and the conditions/type of work being performed.

- While work is in progress outside construction areas shall have at least 33 lux (lx).
- Construction work conducted inside buildings should be provided with at least 55 lux light.
- The means of egress shall be illuminated with emergency and non-emergency lighting to provide a minimum 11 lx measured at the floor. Egress illumination shall be arranged so that the failure of any single lighting unit, including the burning out of an electric bulb will not leave any area in total darkness.

SECTION 10

Physical Hazards and Controls

10.1 Noise

(Reference CH2M HILL SOP HSE-108, *Hearing Conservation*)

CH2M HILL is required to control employee exposure to occupational noise levels of 85 decibels, A-weighted, (dBA) and above by implementing a hearing conservation program that meets the requirements of the OSHA Occupational Noise Exposure standard, 29 CFR 1910.95. A noise assessment may be conducted by the RHSM or designee based on potential to emit noise above 85 dBA and also considering the frequency and duration of the task.

- Areas or equipment emitting noise at or above 90dBA shall be evaluated to determine feasible engineering controls. When engineering controls are not feasible, administrative controls can be developed and appropriate hearing protection will be provided.
- Areas or equipment emitting noise levels at or above 85 dBA, hearing protection must be worn.
- Employees exposed to 84 dBA or a noise dose of 50% must participate in the Hearing Conservation program including initial and annual (as required) audiograms.
- The RHSM will evaluate appropriate controls measures and work practices for employees who have experienced a standard threshold shift (STS) in their hearing.
- Employees who are exposed at or above the action level of 85 dBA are required to complete the online Noise Training Module located on CH2M HILL's virtual office.
- Hearing protection will be maintained in a clean and reliable condition, inspected prior to use and after any occurrence to identify any deterioration or damage, and damaged or deteriorated hearing protection repaired or discarded.
- In work areas where actual or potential high noise levels are present at any time, hearing protection must be worn by employees working or walking through the area.
- Areas where tasks requiring hearing protection are taking place may become hearing protection required areas as long as that specific task is taking place.
- High noise areas requiring hearing protection should be posted or employees must be informed of the requirements in an equivalent manner.

10.2 Ultraviolet Radiation (sun exposure)

Health effects regarding ultraviolet (UV) radiation are confined to the skin and eyes. Overexposure can result in many skin conditions, including erythema (redness or sunburn), photoallergy (skin rash), phototoxicity (extreme sunburn acquired during short exposures to UV radiation while on certain medications), premature skin aging, and numerous types of skin cancer. Implement the following controls to avoid sunburn.

Limit Exposure Time

- Rotate staff so the same personnel are not exposed all of the time.
- Limit exposure time when UV radiation is at peak levels (approximately 2 hours before and after the sun is at its highest point in the sky).
- Avoid exposure to the sun, or take extra precautions when the UV index rating is high.

Provide Shade

- Take lunch and breaks in shaded areas.
- Create shade or shelter through the use of umbrellas, tents, and canopies.
- Fabrics such as canvas, sailcloth, awning material and synthetic shade cloth create good UV radiation protection.
- Check the UV protection of the materials before buying them. Seek protection levels of 95 percent or greater, and check the protection levels for different colors.

Clothing

- Reduce UV radiation damage by wearing proper clothing; for example, long sleeved shirts with collars, and long pants. The fabric should be closely woven and should not let light through.
- Head protection should be worn to protect the face, ears, and neck. Wide-brimmed hats with a neck flap or “Foreign Legion” style caps offer added protection.
- Wear UV-protective sunglasses or safety glasses. These should fit closely to the face. Wrap-around style glasses provide the best protection.

Sunscreen

- Apply sunscreen generously to all exposed skin surfaces at least 20 minutes before exposure, allowing time for it to adhere to the skin.
- Re-apply sunscreen at least every 2 hours, and more frequently when sweating or performing activities where sunscreen may be wiped off.
- Choose a sunscreen with a high sun protection factor (SPF). Most dermatologists advocate SPF 30 or higher for significant sun exposure.
- Waterproof sunscreens should be selected for use in or near water, and by those who perspire sufficiently to wash off non-waterproof products.
- Check for expiration dates, because most sunscreens are only good for about 3 years. Store in a cool place out of the sun.
- No sunscreen provides 100 percent protection against UV radiation. Other precautions must be taken to avoid overexposure.

10.3 Temperature Extremes

Each employee is responsible for the following:

- Recognizing the symptoms of heat or cold stress;
- Taking appropriate precautionary measures to minimize their risk of exposure to temperature extremes (see following sections); and
- Communicating any concerns regarding heat and cold stress to their supervisor or SC.

10.3.1 Heat Stress Monitoring and Prevention

It is not anticipated that personnel will have to wear Level C PPE during the execution of their assigned tasks on this project. However, workers should be aware of necessary procedures to prevent heat related disorders, be cognizant of the signs and systems that indicate heat related disorders are occurring and know when first aid or medical treatment may be required to treat heat related disorders. The following information is provided as procedural information to monitor and prevent heat related injuries to site workers, while performing assigned tasks.

- It is recommended that personnel drink 16 ounces of water before beginning work. Disposable cups or containers and water maintained at 50°F to 60°F shall be available. Under severe conditions, drink 1 to 2 cups every 20 minutes, for a total of 1 to 2 gallons per day. Do not use alcohol in place of water or other nonalcoholic fluids. Decrease your intake of coffee and caffeinated soft drinks during working hours.
- Acclimate yourself by slowly increasing workloads (e.g., do not begin with extremely demanding activities).
- Use cooling devices, such as cooling vests, to aid natural body ventilation. These devices add weight, so their use should be balanced against efficiency.
- Use mobile showers or hose-down facilities to reduce body temperature and cool protective clothing.
- Conduct field activities in the early morning or evening and rotate shifts of workers, if possible.
- Whenever possible, avoid direct sun, which can decrease physical efficiency and increase the probability of heat stress. Take regular breaks in a cool, shaded area. Use a wide-brim hat or an umbrella when working under direct sun for extended periods.
- Provide adequate shelter/shade to protect personnel against radiant heat (sun, flames, hot metal).
- Maintain good hygiene standards by frequently changing clothing and showering.
- Observe one another for signs of heat stress. Persons who experience signs of heat syncope, heat rash, or heat cramps should consult the SSHO to avoid progression of heat-related illness.

To counteract the onset of heat stress symptoms, a work-break regimen must be established during the executed work. Workers with elevated core temperatures shall be allowed to rest and lower core body temperature to normal status when any one condition is exceeded:

- Visual signs and symptoms of heat stress are present in a worker.
- It is determined that a worker’s core body temperature exceeds 100.4 degrees F.
- Personnel reactions, physical conditions or extreme atmospheric conditions warrant.

Note: In the event site personnel are required to perform work in Modified Level D or Level C PPE in ambient temperatures in excess of 70 degrees F (without regard to humidity evaluation) occurs for more than 45 minutes then this condition shall also constitute a requirement for initiating a proper work/rest regiment and Wet Bulb Globe Temperature (WBGT) Index or physiological shall be performed.

The signs and symptoms and treatment requirements of heat related disorders are as follows:

SYMPTOMS AND TREATMENT OF HEAT STRESS					
	Heat Syncope	**Heat Rash**	**Heat Cramps**	**Heat Exhaustion**	**Heat Stroke**
Signs and Symptoms	Sluggishness or fainting while standing erect or immobile in heat.	Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure.	Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours.	Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid thready pulse and low blood pressure; oral temperature normal or low	Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature (104F or above).

SYMPTOMS AND TREATMENT OF HEAT STRESS					
	Heat Syncope	**Heat Rash**	**Heat Cramps**	**Heat Exhaustion**	**Heat Stroke**
Treatment	Remove to cooler area. Remove outer impermeable protective clothing. Rest victim lying down in supine position (on back, facing up) with head shoulders slightly elevated. Increase fluid intake. Recovery usually is prompt and complete. Where effected person is conscious, have them loosen their clothing to promote cooling surface between clothing/body.	Remove to cooler area. Remove outer impermeable protective clothing. Remove to cooler area. Remove outer impermeable protective clothing. Rest victim lying down in supine position (on back, facing up) with head shoulders slightly elevated.. Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection. Where effected person is conscious, have them loosen their clothing to promote cooling surface between clothing/body.	Remove to cooler area. Remove outer impermeable protective Rest victim lying down in supine position (on back, facing up) with head shoulders slightly elevated. Increase fluid intake. Where effected person is conscious, have them loosen their clothing to promote cooling surface between clothing/body.	Remove to cooler area. Rest victim lying down in supine position (on back, facing up) with head shoulders slightly elevated. Administer fluids by mouth. Victim shall be given sips of cool potable water or electrolyte replenishing fluids. Seek medical attention immediately. Where effected person is conscious, have them loosen their clothing to promote cooling surface between clothing/body.	Remove to cooler area to avoid further exposure to the heat/sun. Rest victim lying down in supine position (on back, facing up) with head shoulders slightly elevated. Where effected person is conscious, have them loosen their clothing to promote cooling surface between clothing/body. Call ambulance, and get medical attention immediately! Provide sips of cool water to if fully conscious and not nauseous or vomiting. Fan or have bags of ice (if available) placed behind the neck, in the axilia and groin areas. Cool rapidly by soaking clothing in cool–but not cold–water. This procedure shall only be performed where directed by someone with medical training/ licensure (i.e. EMT, physician) and only as a life saving precaution. Evaluate employee's condition by an occupational physician prior to resuming normal assigned duties.

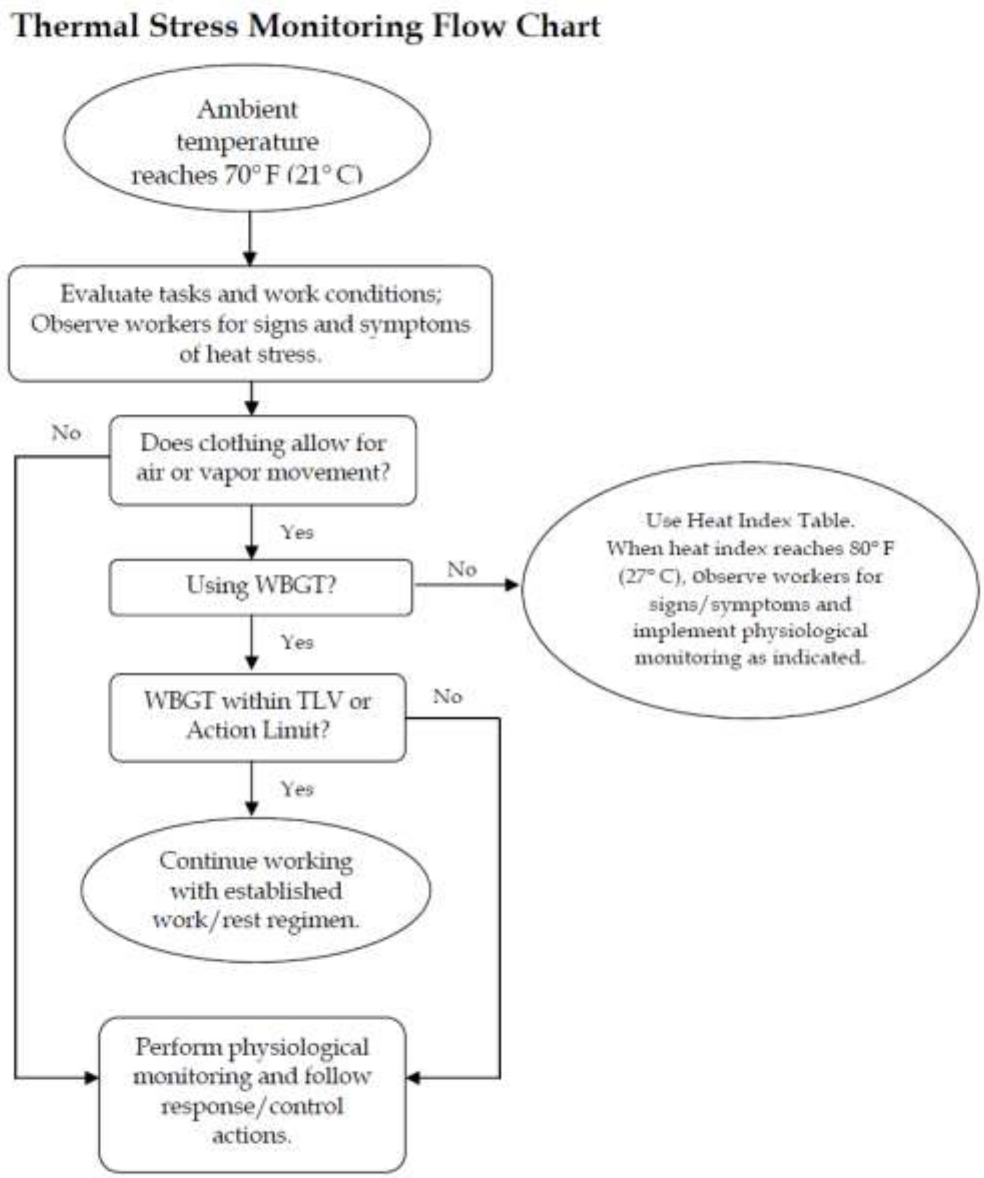
10.3.2 Monitoring Heat Stress

Heat Stress monitoring procedures must be implemented when the ambient air temperature exceeds 70°F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress, or when workers are required to wear impermeable protective clothing (Saranex, Tyvek or Rain Gear) to perform their assigned duties.

In these conditions, physiological monitoring will be facilitated by the use of automatic blood pressure monitors and by taking body temperature measurements monitored with aural or oral thermometers. All temperature measurement devices shall be affixed with disposable covers or protectors to ensure exposure to blood borne pathogens does not occur.

The heart rate (HR) should be measured by the radial pulse for 30 seconds, as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 100 beats/minute, or 20 beats/minute above resting pulse. If the HR is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same. If the pulse rate still exceeds 100 beats/minute at the beginning of the next rest period, the work cycle should be further shortened by 33 percent. The procedure is continued until the rate is maintained below 100 beats/minute, or 20 beats/minute above resting pulse.

Thermal Stress Monitoring



Permeable Clothing – Monitoring Using WBGT

A Wet Bulb Globe Thermometer (WBGT) is the established and preferred means of measuring the environmental factors associated with heat stress and for providing indication of when physiological monitoring or rest regimens should be incorporated into the work schedule. The WBGT is the composite temperature used to estimate the effect of temperature, humidity, wind speed, and solar radiation on the human body.

When permeable work clothes are worn (street clothes or clothing ensembles over modesty clothes), physiological monitoring may be required based on the outcome of the WBGT measurements, taking into account the clothing adjustment factors. Use of the WBGT should generally begin when the heat index reaches 80° F (27° C) as indicated in the Heat Index Table below, or when workers exhibit symptoms of heat stress as indicated in Attachment 1.

If the WBGT is within the TLV (acclimatized workers) or Action Limit (unacclimatized workers) per the tables below, then work may continue while maintaining the established work/rest regimen. If the WBGT reading meets or exceeds either the TLV or Action Level for a work/rest regimen of 15 minutes work and 45 minutes rest, then physiological monitoring will be implemented.

Screening Criteria for TLV and Action Limit for Heat Stress Exposure								
Allocation of work in a cycle of work and recovery	**TLV (WBGT Values in ˚F/C˚) (Acclimatized Workers)**				**Action Limit (WBGT Values in ˚F/˚C˚) (Unacclimatized Workers)**			
	Light	**Moderate**	**Heavy**	**Very Heavy**	**Light**	**Moderate**	**Heavy**	**Very Heavy**
75-100%	88/31	82/28	--	--	82/28	77/25	--	--
50-75%	88/31	84/29	82/28	--	83/29	79/26	75/24	--
25-50%	90/32	86/30	84/29	82/28	85/30	81/27	78/26	76/25
0-25%	91/33	89/32	87/31	86/30	86/30	84/29	82/28	81/27

Work Category Descriptions:	
Light	Sitting or standing with light manual work using hands or arms; occasional walking.
Moderate	Sustained moderate hand, arm, and leg work; light pushing and pulling; normal walking.
Heavy	Intense arm and trunk work, carrying, shoveling, manually sawing, pushing and pulling heavy loads, walking at a fast pace.
Very Heavy	Very intense activity at fast to maximum pace.

Notes:
WBGT values are expressed to the nearest degree.
"—"Dashes indicate the need for physiological monitoring because screening criteria are not recommended for this type of work.

Clothing Adjustment Factors for Some Clothing Ensembles*	
Clothing Type	Addition to WBGT ˚F/˚C˚
Work Clothes (sleeved shirt and pants)	0/0
Cloth (woven material) coveralls	0/0
Double-layer woven clothing	5.4/3
Polypropylene coveralls	0.9/0.5
Limited Use Vapor barrier coveralls	19.8/11

* These values must not be used for completely encapsulating (impermeable) coveralls/suits. Coveralls assume that only modesty clothing is worn beneath.

Thermal Stress Monitoring – Permeable or Impermeable Clothing

When permeable work clothes are worn (street clothes or clothing ensembles over street clothes), regularly observe workers for signs and symptoms of heat stress and implement physiological monitoring as indicated below. This should start when the heat index reaches 80° F (27° C) [see Heat Index Table below], or sooner if workers exhibit symptoms of heat stress indicated in the table above. These heat index values were devised for shady, light wind conditions; exposure to full sunshine can increase the values by up to 15°F (8°C). Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

When wearing **impermeable clothing** (e.g., clothing doesn't allow for air or water vapor movement such as Tyvek), physiological monitoring as described below shall be conducted when the ambient temperature reaches 70° F (21° C) or at a lower temperature when workers begin to exhibit signs and symptoms of heat stress.

Heat Index	Possible Heat Disorders	Minimum Frequency of Physiological Monitoring
80°F - 90°F (27°C - 32°C)	Fatigue possible with prolonged exposure and/or physical activity	Observe Workers for signs of heat stress and implement physiological monitoring if warranted.
90°F - 105°F (32°C - 41°C)	Sunstroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity	Every 2 hours, or sooner, if signs of heat stress are observed.
105°F - 130°F (41°C - 54°C)	Sunstroke, heat cramps, or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity.	Every 60 minutes or sooner if signs of heat stress are observed.
130°F or Higher (54°C or Higher)	Heat/Sunstroke highly likely with continued exposure.	Every 30 minutes or sooner if signs of heat stress are observed.

Source: National Weather Service

Physiological Monitoring and Associated Actions

The following physiological monitoring protocol below, using either radial pulse or aural temperature, will occur when the heat index is 80 degrees F or greater (or when personnel exhibit signs of heat stress), the following will be performed:

- The sustained heart rate during the work cycle should remain below 180 beats per minute (bpm) minus the individual's age (e.g. 180 – 35 year old person = 145 bpm). The sustained heart rate can be estimated by measuring the heart rate at the radial pulse for 30 seconds as quickly as possible prior to starting the rest period.
- The heart rate after one minute rest period should not exceed 120 beats per minute (bpm).
- If the heart rate is higher than 120 bpm, the next work period should be shortened by 33 percent, while the length of the rest period stays the same.
- If the pulse rate still exceeds 120 bpm at the beginning of the next rest period, the following work cycle should be further shortened by 33 percent.
- Continue this procedure until the rate is maintained below 120 bpm.
- Alternately, the body temperature can be measured, either oral or aural (ear), before the workers have something to drink.
- If the oral or aural temperature exceeds 99.6° F (37.6 ° F) at the beginning of the rest period, the following work cycle should be shortened by 33 percent.
- Continue this procedure until the oral or aural (ear) temperature is maintained below 99.6 ° F (37.6° C). While an accurate indication of heat stress, oral temperature is difficult to measure in the field, however, a digital aural (aural) thermometer is easy to obtain and inexpensive to purchase.
- Use the form attached to this HSP to track workers' measurements and actions taken.

Procedures for when Heat Illness Symptoms are Experienced

- **Always** contact the RHSM when any heat illness related symptom is experienced so that controls can be evaluated and modified, if needed.
- In the case of cramps, reduce activity, increase fluid intake, move to shade until recovered.
- In the case of all other heat-related symptoms (fainting, heat rash, heat exhaustion), and if the worker is a CH2M HILL worker, contact the occupational physician at 1-866-893-2514 and immediate supervisor.

- In the case of heat stroke symptoms, call 911, have a designee give location and directions to ambulance service if needed, follow precautions under the emergency medical treatment of this HSP.
- Follow the Incident Notification, Reporting, and Investigation section of this HSP.

10.3.3 Cold

General

Low ambient temperatures increase the heat lost from the body to the environment by radiation and convection. In cases where the worker is standing on frozen ground, the heat loss is also due to conduction.

Wet skin and clothing, whether because of water or perspiration, may conduct heat away from the body through evaporative heat loss and conduction. Thus, the body cools suddenly when chemical protective clothing is removed if the clothing underneath is perspiration soaked.

Movement of air across the skin reduces the insulating layer of still air just at the skin's surface. Reducing this insulating layer of air increases heat loss by convection.

Non-insulating materials in contact or near-contact with the skin, such as boots constructed with a metal toe or shank, conduct heat rapidly away from the body.

Certain common drugs, such as alcohol, caffeine, or nicotine, may exacerbate the effects of cold, especially on the extremities. These chemicals reduce the blood flow to peripheral parts of the body, which are already high-risk areas because of their large surface area to volume ratios. These substances may also aggravate an already hypothermic condition.

Precautions

- Be aware of the symptoms of cold-related disorders, and wear proper, layered clothing for the anticipated fieldwork. Appropriate rain gear is a must in wet weather.
- Consider monitoring the work conditions and adjusting the work schedule using guidelines developed by the U.S. Army (wind-chill index) and the National Safety Council (NSC).
- Wind-Chill Index (below) is used to estimate the combined effect of wind and low air temperatures on exposed skin. The wind-chill index does not take into account the body part that is exposed, the level of activity, or the amount or type of clothing worn. For those reasons, it should only be used as a guideline to warn workers when they are in a situation that can cause cold-related illnesses.
- Persons who experience initial signs of immersion foot, frostbite, and/or hypothermia should report it immediately to their supervisor/PM to avoid progression of cold-related illness.
- Observe one another for initial signs of cold-related disorders.
- Obtain and review weather forecast – be aware of predicted weather systems along with sudden drops in temperature, increase in winds, and precipitation.

SYMPTOMS AND TREATMENT OF COLD STRESS			
	Immersion (Trench) Foot	**Frostbite**	**Hypothermia**
Signs and Symptoms	Feet discolored and painful; infection and swelling present.	Blanched, white, waxy skin, but tissue resilient; tissue cold and pale.	Shivering, apathy, sleepiness; rapid drop in body temperature; glassy stare; slow pulse; slow respiration.
Treatment	Seek medical treatment immediately.	Remove victim to a warm place. Re-warm area quickly in warm–but **not** hot–water. Have victim drink warm fluids, but **not** coffee or alcohol. Do not break blisters. Elevate the injured area, and get medical attention.	Remove victim to a warm place. Have victim drink warm fluids, but **not** coffee or alcohol. Get medical attention.

Wind Chill Chart

Temperature (°F)

Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes; 10 minutes; 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

10.4 Radiological Hazards

Refer to CH2M HILL's Core Standard, Radiological Control and Radiological Controls Manual for additional requirements.

Hazards	Controls
None Known	None Required

SECTION 11

Biological Hazards and Controls

Biological hazards are everywhere and change with the region and season. If you encounter a biological hazard that has not been identified in this plan, contact the RHSM so that a revision to this plan can be made. Whether it is contact with a poisonous plant, a poisonous snake, or a bug bite, do not take bites or stings lightly. If there is a chance of an allergic reaction or infection, or to seek medical advice on how to properly care for the injury, contact the immediate supervisor.

11.1 Bees and Other Stinging Insects

Bees and other stinging insects may be encountered almost anywhere and may present a serious hazard, particularly to people who are allergic. Watch for and avoid nests. Keep exposed skin to a minimum. Carry a kit if you have had allergic reactions in the past, and inform your supervisor and/or a buddy. If you are stung, contact the worker's immediate supervisor. If a stinger is present, remove it carefully with tweezers. Wash and disinfect the wound, cover it, and apply ice. Watch for an allergic reaction if you have never been stung before. Call 911 if the reaction is severe.

11.2 Feral Dogs

Avoid all dogs – both leashed and stray. Do not disturb a dog while it is sleeping, eating, or caring for puppies. If a dog approaches to sniff you, stay still. An aggressive dog has a tight mouth, flattened ears and a direct stare. If you are threatened by a dog, remain calm, do not scream and avoid eye contact. If you say anything, speak calmly and firmly. Do not turn and run, try to stay still until the dog leaves, or back away slowly until the dog is out of sight or you have reached safety (e.g. vehicle). If attacked, retreat to vehicle or attempt to place something between you and the dog. If you fall or are knocked to the ground, curl into a ball with your hands over your head and neck and protect your face. If bitten, contact the worker's immediate supervisor. Report the incident to the local authorities.

11.3 Hantavirus

Hantavirus pulmonary syndrome (HPS) is a disease caused by a virus which can be transmitted from certain rodents to humans and is prevalent throughout the southwestern United States. Avoid disturbing rodent nests.

Nesting material and droppings must be removed if work is necessary in a rodent-infested area. PPE for removal shall include:

- Tyvek coveralls;
- Rubber boots or disposable shoe covers;
- Rubber, latex, or vinyl gloves;
- Respiratory protection such as a full face or half-mask air-purifying respirator with a high-efficiency particulate air (HEPA) filter; and
- Protective goggles if wearing a half-mask respirator.

Spray any urine, droppings, and nesting materials with either a bleach and water solution (1 parts bleach to 9 parts water) or a household disinfectant prepared according to the label instructions for dilution and disinfection time. Soak well and let stand for 15 minutes. Use a paper towel or rag to pick up the materials and dispose of them.

Mop floors after spraying them using bleach and water solution or a disinfectant. Dirt floors can be sprayed with either bleach and water solution or a disinfectant.

Personal protective gear shall be decontaminated upon removal at the end of the day. All potentially infective waste material (including respirator filters) from clean-up operations shall be double-bagged in plastic bags.

Symptoms of HPS

Symptoms develop between 14 and 31 days after exposure to infected rodents and include fatigue, fever, and muscle aches, especially the large muscle groups--thighs, hips, back and sometimes shoulders. About half of all HPS patients also experience headaches, dizziness, chills and/or abdominal pain. Four to 10 days after the initial phase of the illness, late symptoms of HPS may appear. These include coughing and shortness of breath. If you develop symptoms suggestive of HPS, call the worker's immediate supervisor.

11.4 Mosquito Bites

Due to the recent detection of the West Nile Virus in the southwestern United States it is recommended that preventative measures be taken to reduce the probability of being bitten by mosquitoes whenever possible. Mosquitoes are believed to be the primary source for exposure to the West Nile Virus as well as several other types of encephalitis. The following guidelines should be followed to reduce the risk of these concerns for working in areas where mosquitoes are prevalent:

- Stay indoors at dawn, dusk, and in the early evening;
- Wear long-sleeved shirts and long pants whenever you are outdoors;
- Spray clothing with repellents containing permethrin or N,N-diethyl-meta-toluamide (DEET) since mosquitoes may bite through thin clothing;
- Apply insect repellent sparingly to exposed skin. An effective repellent will contain 35% DEET. Repellents may irritate the eyes and mouth, so avoid applying repellent to the hands; and
- Whenever you use an insecticide or insect repellent, be sure to read and follow the manufacturer's DIRECTIONS FOR USE, as printed on the product.

Vitamin B and "ultrasonic" devices are NOT effective in preventing mosquito bites.

Symptoms of Exposure to the West Nile Virus

Most infections are mild, and symptoms include fever, headache, and body aches, occasionally with skin rash and swollen lymph glands. More severe infection may be marked by headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, paralysis, and, rarely, death.

The West Nile Virus incubation period is from 3 to 15 days.

Contact the project RHSM with questions, and immediately report any suspicious symptoms to your supervisor, PM, and contact the worker's immediate supervisor.

11.5 Poison Ivy, Poison Oak, and Poison Sumac

Poison ivy, poison oak, and poison sumac typically are found in brush or wooded areas. They are more commonly found in moist areas or along the edges of wooded areas. Shrubs are usually 12 to 30 inches high, or can also be a tree-climbing vine, with triple leaflets and short, smooth hair underneath. Plants are red and dark green in spring and summer, with yellowing leaves anytime especially in dry areas. Leaves may achieve bright reds in fall, but plants lose its (yellowed, then brown) leaves in winter, leaving toxic stems. All parts of the plant remain toxic throughout the seasons. These plants contain urushiol a colorless or pale yellow oil that oozes from any cut or crushed part of the plant, including the roots, stems and leaves and causes allergic skin reactions when contacted. The oil is active year round.

Become familiar with the identity of these plants (see below). Wear protective clothing that covers exposed skin and clothes. Avoid contact with plants and the outside of protective clothing. If skin contacts a plant, wash the area with soap and water immediately. If the reaction is severe or worsens, seek medical attention.

Poison Ivy

Poison Sumac

Poison Oak

Contamination with poison ivy, sumac or oak can happen through several pathways, including:

- Direct skin contact with any part of the plant (even roots once above ground foliage has been removed).
- Contact with clothing that has been contaminated with the oil.
- Contact from removing shoes that have been contaminated (shoes are coated with urishol oil).
- Sitting in a vehicle that has become contaminated.
- Contact with any objects or tools that have become contaminated.
- Inhalation of particles generated by weed whacking, chipping, vegetation clearing.

If you must work on a site with poison ivy, sumac or oak the following precautions are necessary:

- Do not drive vehicles onto the site where it will come into contact with poison ivy, sumac or oak. Vehicles which need to work in the area, such as drill rigs or heavy equipment must be washed as soon as possible after leaving the site.
- All tools used in the poison ivy, sumac or oak area, including those used to cut back poison oak, surveying instruments used in the area, air monitoring equipment or other test apparatus must be decontaminated before they are placed back into the site vehicle. If on-site decontamination is not possible, use plastic to wrap any tools or equipment until they can be decontaminated.
- Personal protective equipment, including Tyvek coveralls, gloves, and boot covers must be worn. PPE must be placed into plastic bags and sealed if they are not disposed immediately into a trash receptacle.
- As soon as possible following the work, shower to remove any potential contamination. Any body part with suspected or actual exposure should be washed with Zanfel, Tecnu or other product designed for removing urushiol. If you do not have Zanfel or Tecnu wash with cold water. Do not take a bath, as the oils can form and invisible film on top of the water and contaminate your entire body upon exiting the bath.
- Tecnu may also be used to decontaminate equipment.
- Use IvyBlock or similar products to prevent poison oak, ivy and sumac contamination. Check with the closest CH2M HILL warehouse to see if these products are available. Follow all directions for application.

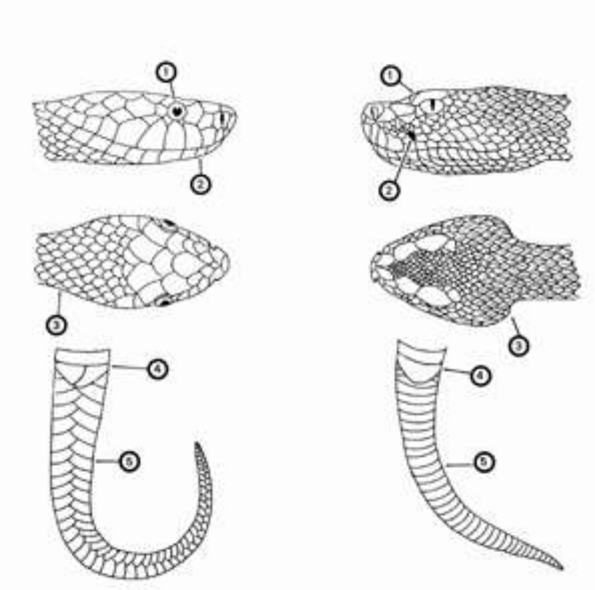
If you do come into contact with one of these poisonous plants and a reaction develops, contact your supervisor.

11.6 Snakes

Snakes typically are found in underbrush and tall grassy areas. If you encounter a snake, stay calm and look around; there may be other snakes. Turn around and walk away on the same path you used to approach the area. If bitten by a snake, wash and immobilize the injured area, keeping it lower than the heart if possible. Call the worker's immediate supervisor immediately. Do not apply ice, cut the wound, or apply a tourniquet. Try to identify the type of snake: note color, size, patterns, and markings. Below is a guide to identifying poisonous snakes from non-poisonous snakes.

Identification of Poisonous Snakes

Major Identification Features Non-venomous Snake	Major Identification Features Venomous Snake
1. Round pupils 2. No sensing pit 3. Head slightly wider than neck 4. Divided anal plate 5. Double row of scales on the underside of the tail	1. Elliptical pupils 2. Sensing pit between eye and nostril 3. Head much wider than neck 4. Single anal plate 5. Single scales on the underside of the tail



11.7 Spiders - Brown Recluse and Widow

The Brown Recluse spider can be found most anywhere in the United States. It varies in size in shape, but the distinguishing mark is the violin shape on its body. They are typically non-aggressive. Keep an eye out for irregular, pattern-less webs that sometimes appear almost tubular built in a protected area such as in a crevice or between two rocks. The spider will retreat to this area of the web when threatened.

The Black Widow, Red Widow and the Brown Widow are all poisonous. Most have globose, shiny abdomens that are predominantly black with red markings (although some may be pale or have lateral stripes), with moderately long, slender legs. These spiders are nocturnal and build a three-dimensional tangled web, often with a conical tent of dense silk in a corner where the spider hides during the day.

Hazard Controls

- Inspect or shake out any clothing, shoes, towels, or equipment before use.
- Wear protective clothing such as a long-sleeved shirt and long pants, hat, gloves, and boots when handling stacked or undisturbed piles of materials.
- Minimize the empty spaces between stacked materials.
- Remove and reduce debris and rubble from around the outdoor work areas.
- Trim or eliminate tall grasses from around outdoor work areas.
- Store apparel and outdoor equipment in tightly closed plastic bags.
- Keep your tetanus boosters up-to-date (every 10 years). Spider bites can become infected with tetanus spores.

If you think you have been bit by a poisonous spider, immediately call the worker's immediate supervisor and follow the guidance below:

- Remain calm. Too much excitement or movement will increase the flow of venom into the blood;
- Apply a cool, wet cloth to the bite or cover the bite with a cloth and apply an ice bag to the bite;
- Elevate the bitten area, if possible;
- Do not apply a tourniquet. Do not try to remove venom; and
- Try to positively identify the spider to confirm its type. If the spider has been killed, collect it in a plastic bag or jar for identification purposes. Do not try to capture a live spider—especially if you think it is a poisonous spider.

Black Widow

Red Widow

Brown Widow

Brown Recluse

11.8 Ticks

Every year employees are exposed to tick bites at work and at home putting them at risk of illness. Ticks typically are in wooded areas, bushes, tall grass, and brush. Ticks are black, black and red, or brown and can be up to one-quarter inch (6.4 mm) in size.

In some geographic areas exposure is not easily avoided. Wear tightly woven light-colored clothing with long sleeves and pant legs tucked into boots; spray only outside of clothing with permethrin or permanone and spray skin with only DEET; and check yourself frequently for ticks.

Where site conditions (vegetation above knee height, tick endemic area) or when tasks (e.g., having to sit or kneel in vegetation) diminish the effectiveness of the other controls mentioned above, bug-out suits (check with your local or regional warehouse) or Tyvek shall be used. Bug-out suits are more breathable than Tyvek.

Take precautions to avoid exposure by including pre-planning measures for biological hazards prior to starting field work. Avoid habitats where possible, reduce the abundance through habitat disruption or application of acracide. If these controls aren't feasible, contact your local or regional warehouse for preventative equipment such as repellants, protective clothing and tick removal kits. Use the buddy system and perform tick inspections prior to entering the field vehicle. If ticks were not planned to be encountered and are observed, do not continue field work until these controls can be implemented.

See Tick Fact Sheet attached to this HSP for further precautions and controls to implement when ticks are present. If bitten by a tick, follow the removal procedures found in the tick fact sheet.

Be aware of the symptoms of Lyme disease or Rocky Mountain spotted fever (RMSF). Lyme disease is a rash that might appear that looks like a bullseye with a small welt in the center. RMSF is a rash of red spots under the skin 3 to 10 days after the tick bite. In both RMSF and Lyme disease, chills, fever, headache, fatigue, stiff neck, and bone pain may develop. If symptoms appear, again contact your medical provider, Human Resources representative, supervisor and H&S manager.

Be sure to complete an Incident Report (either use the Hours and Incident Tracking System [HITS] system on the VO) if you do come in contact with a tick.

SECTION 12

Contaminants of Concern

The table below summarizes the potential contaminants of concern (COC) and their occupational exposure limit and signs and symptoms of exposure. The table also includes the maximum concentration of each COC and the associated location and media that was sampled (groundwater, soil boring, surface soil). These concentrations were used to determine engineering and administrative controls described in the "Project-Specific Hazard Controls" section of this HSP, as well as PPE and site monitoring requirements.

As indicated in Section 3.2 above, soil and sediment within Site 7 has been deemed clean at levels protective of future industrial land use. However, during previous investigation activities, the upgradient buildings were inaccessible because Plant 3 remained in operation. This work involves sampling beneath the former footprints of the buildings that are upgradient of the remediated area to determine if they are an ongoing source of contamination to the discharge area. The primary COCs in this area are explosives residue. The table below includes prior dada from surface water and sediment downgradient of the building footprints; there is currently no data from beneath the building footprints.

There have been no historical releases reported or documented at Site 32, but beaded elemental mercury was discovered around the base of the trickling filter during excavation of the structure. The source of this mercury was likely the mercury-containing bearings located in the distributor arms of the trickling filter tank. A soil removal task was completed, but there is no documentation of the removal activities and no confirmation samples were collected. Sampling will be conducted to determine if there is contamination in the area. The COC for this site is thought to be mercury, but samples will be analyzed for other potential contaminants as well.

Contaminants of Concern					
Contaminant	**Location and Maximum[a] Concentration (ppm)**	**Exposure Limit[b]**	**IDLH[c]**	**Symptoms and Effects of Exposure**	**PIP[d] (eV)**
Explosives (Site 7)					
HMX	SD: 3,200 ug/kg	Not Established	Not Established	Headache, fatigue, cyanosis, and shortness of breath on mild exertion; if exposure is severe, loss of coordination, nausea, drowsiness, vomiting, and rapid heartbeat may occur.	N/A
RDX	SD: 14,000 ug/kg GW: 180 ug/L	1.5 mg/m3	Not Established	Headache, fatigue, cyanosis, and shortness of breath on mild exertion; if exposure is severe, loss of coordination, nausea, drowsiness, vomiting, and rapid heartbeat may occur.	N/A
4,2,6-DNT	SD: 40,000 ug/kg GW: 38 ug/L	1.5 mg/m3	50 mg/m3	Headache, fatigue, cyanosis, and shortness of breath on mild exertion; if exposure is severe, loss of coordination, nausea, drowsiness, vomiting, and rapid heartbeat may occur.	N/A
Amino-DNT	SD: 84.7 ug/kg	1.5 mg/m3	Not Established	Headache, fatigue, cyanosis, and shortness of breath on mild exertion; if exposure is severe, loss of coordination, nausea, drowsiness, vomiting, and rapid heartbeat may occur.	N/A
VOC's (Site 7)					
1,1- Dichloroethane	GW: 58 ug/L	100ppm	3000ppm	irritation skin; central nervous system depression	11.06
1,1,1-Trichloroethane	GW: 200 ug/L	350ppm	700ppm	irritation eyes, skin; headache, lassitude (weakness, exhaustion),	11.00
METALS (Site 32)					
Cadmium	N/A	0.005 mg/m3	9 mg/m3 Ca	Pulmonary edema, coughing, chest tightness/pain, headache, chills, muscle aches, nausea, vomiting, diarrhea, difficulty breathing, loss of sense of smell, emphysema, mild anemia	N/A
Mercury	N/A	0.025 mg/m3	10 mg/m3	Skin and eye irritation, cough, chest pain, difficult breathing, bronchitis, pneumontitis, tremors, insomnia, irritability, indecision, headache, fatigue, weakness, GI disturbance	N/A
Silver	N/A	0.1 mg/m3	10 mg/m3	Sweet metal taste, dry throat, cough, tight chest, chills	N/A

Footnotes:

[a] Specify sample-designation and media: SB (Soil Boring), A (Air), D (Drums), GW (Groundwater), L (Lagoon), TK (Tank), SD (Sediment), SS (Surface Soil), SL (Sludge), SW (Surface Water).
[b] Appropriate value of permissible exposure limit (PEL), recommended exposure limit (REL), or threshold limit value (TLV) listed.
[c] IDLH = immediately dangerous to life and health (units are the same as specified "Exposure Limit" units for that contaminant); NL = No limit found in reference materials; CA = Potential occupational carcinogen.
[d] PIP = photoionization potential; NA = Not applicable; UK = Unknown.
eV = electron volt
mg/kg = milligram per kilogram
mg/m^3 = milligrams per cubic meter
ug/m^3 = micrograms per cubic meter

SECTION 13

Site Monitoring

(Reference CH2M HILL SOP HSE-207, *Exposure Monitoring for Airborne Chemical Hazards*)

Based on site history and prior remediation conducted at both sites, it is not anticipated that employees performing the drilling and sampling will be exposed to potential contaminants above permissible levels. Still, given that this is an investigation, air monitoring for potential contaminants will be conducted as described below. Analytical results obtained from this sampling effort will be used to determine future air monitoring requirements, if any.

When performing site monitoring, record all the information, such as in a field logbook. Note date and time, describe monitoring location (for example, in breathing zone, at source and site location), and what the reading is. If any action levels are reached, note it in the field logbook and note the action taken.

Exposure records (air sampling) must be preserved for the duration of employment plus thirty years. Ensure that copies of the field log book are maintained in the project file.

Copies of all project exposure records (e.g., copies of field logbook pages where air monitoring readings are recorded and associated calibration) shall be sent to the regional SPA for retention and maintained in the project files.

13.1 Direct Reading Monitoring Specifications

Instrument	Tasks	Action Levels[a]	Action to be Taken when Action Level reached	Frequency [b]	Calibration
PID: MiniRAE or MultiRAE PID with 11.7 eV lamp or equivalent	Drilling, sampling, IDW Mgmt. & Pore testing at Site 7	<5 ppm 5 -25 ppm >25 ppm	Level D Level C Stop work to determine need for Level B	Initially and periodically during task	Daily
Mercury Vapor Analyzer (i.e. Jerome 411 or equivalent)	Intrusive work at Site 32	< 0.025 mg/m^3 > 0.025 mg/m^3	Level D Stop work and call HSM prior to upgrading to Level C	Initially and periodically during task	Daily
Dust (visual)	Intrusive activities at both sites	No visual dust Visual dust	Continue work Implement dust control	Throughout intrusive activities	NA
Nose-Level Monitor	Drilling	<85 dB(A) 85-120 dB(A) 120 dB(A)	No action required Hearing protection required Stop; re-evaluate	Initially and periodically during task	Daily

[a] Action levels apply to sustained breathing-zone measurements above background.
[b] The exact frequency of monitoring depends on field conditions and is to be determined by the SC; generally, every 5 to 15 minutes if acceptable; more frequently may be appropriate.

13.2 Calibration Specifications

(Refer to the respective manufacturer's instructions for proper instrument-maintenance procedures)

Instrument	Gas	Span	Reading	Method
PID: 11.7 eV bulb	100 ppm isobutylene	RF = 1.0	100 ppm	1.5 lpm reg T-tubing
Mercury Vapor Analyzer	Follow manufacturer specification for field calibration.			

Calibrate air monitoring equipment daily (or prior to use) in accordance with the instrument's instructions. Document the calibration in the field logbook (or equivalent) and include the following information:

- Instrument name
- Serial Number
- Owner of instrument (for example, CH2M HILL, HAZCO)
- Calibration gas (including type and lot number)
- Type of regulator (for example, 1.5 lpm)
- Type of tubing (for example, direct or T-tubing)
- Ambient weather condition (for example, temperature and wind direction)
- Calibration/instrument readings
- Operator's name and signature
- Date and time

13.3 Integrated Personal Air Sampling

Sampling, in addition to real-time monitoring, may be required by other OSHA regulations where there may be exposure to certain contaminants. Air sampling typically is required when site contaminants include lead, cadmium, arsenic, asbestos, and certain volatile organic compounds at concentrations indicating that action levels may be exceeded. Integrated personal sampling is not currently required for this field effort. Contact the HSM if air monitoring action levels indicated above are exceeded and the HSM will determine the need to perform integrated sampling.

SECTION 14

Personal Protective Equipment

(Reference CH2M HILL- SOP HSE-117, *Personal Protective Equipment*)

14.1 Required Personal Protective Equipment

PPE must be worn by employees when actual or potential hazards exist and engineering controls or administrative practices cannot adequately control those hazards.

A PPE assessment has been conducted by the RHSM based on project tasks (see PPE specifications below). Verification and certification of assigned PPE by task is completed by the RHSM that approved this plan. Below are items that need to be followed when using any form of PPE:

- Employees must be trained to properly wear and maintain the PPE;
- In work areas where actual or potential hazards are present at any time, PPE must be worn by employees working or walking through the area;
- Areas requiring PPE should be posted or employees must be informed of the requirements in an equivalent manner;
- PPE must be inspected prior to use and after any occurrence to identify any deterioration or damage;
- PPE must be maintained in a clean and reliable condition;
- Damaged PPE shall not be used and must either be repaired or discarded; and
- PPE shall not be modified, tampered with, or repaired beyond routine maintenance.

The table below outlines PPE to be used according to task based on project-specific hazard assessment. If a task other than the tasks described in this table needs to be performed, contact the RHSM so this table can be updated.

Project-Specific Personal Protective Equipment Requirements

Task	Level	Body	Head	Respirator [b]
Survey Utility Locate	D	Work clothes; safety toed leather work boots and gloves	Hardhat [c] Safety glasses with side shields Ear protection [d]	None required
Drilling Sampling Pore testing IDW Mgmt.	Modified D	Work Clothes or Coveralls. SC to determine body protection based on potential contact with site contaminants. If outer layer of personal clothing cannot be kept clean, then outer cotton coveralls or uncoated Tyvek coveralls shall be worn. (Polycoated Tyvek when there is potential to contact contaminated groundwater or free liquids from drums.) **Boots:** Safety-toe, chemical-resistant boots OR Safety -toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Safety glasses with side shields Ear protection [d]	None required
If action levels in Section 12 are reached.	C	**Coveralls:** Uncoated Tyvek® **Boots:** Safety -toe, chemical-resistant boots OR Safety -toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Splash shield [c] Ear protection [d] Spectacle inserts (if necessary)	APR, full face, MSA Ultratwin or equivalent; GMEP100 cartridges at Site 7, MersorbP100 for Site 32 [e].

Project-Specific Personal Protective Equipment Requirements

Task	Level	Body	Head	Respirator [b]
Work near vehicular traffic ways or earth moving equipment.	Will be worn with All levels of PPE during work around vehicular traffic and/or heavy equipment	Appropriate level of ANSI/ISEA 107-2004 high-visibility safety vests.	Work near vehicular traffic ways or earth moving equipment.	
Equipment decontamination if using pressure washer	Modified D with splash protection	**Coveralls:** Polycoated Tyvek® **Boots:** 16-inch-high steel-toed rubber boots **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Splash shield [c] over safety glasses with side shields or splash goggles Ear protection [d]	None required.

Reasons for Upgrading or Downgrading Level of Protection (with approval of the RHSM)	
Upgrade[f]	**Downgrade**
• Request from individual performing tasks. • Change in work tasks that will increase contact or potential contact with hazardous materials. • Occurrence or likely occurrence of gas or vapor emission. • Known or suspected presence of dermal hazards. • Instrument action levels in the "Site Monitoring" section exceeded.	• New information indicating that situation is less hazardous than originally thought. • Change in site conditions that decrease the hazard. • Change in work task that will reduce contact with hazardous materials.

[a] Modifications are as indicated. CH2M HILL will provide PPE only to CH2M HILL employees.
[b] No facial hair that would interfere with respirator fit is permitted.
[c] Hardhat and splash-shield areas are to be determined by the SC.
[d] Ear protection should be worn when conversations cannot be held at distances of 3 feet (1 meter) or less without shouting.
[e] See cartridge change-out schedule.
[f] Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level C) is permitted only when the PPE requirements have been approved by the RHSM, and an SC qualified at that level is present.

14.2 Respiratory Protection

(Reference CH2M HILL SOP HSE-121, *Respiratory Protection*)

Implement the following when using respiratory protection:

- Respirator users must have completed appropriate respirator training within the past 12 months. Level C training is required for air-purifying respirators (APR) use and Level B training is required for supplied-air respirators (SAR) and self-contained breathing apparatus (SCBA) use. Specific training is required for the use of powered air-purifying respirators (PAPR);
- Respirator users must complete the respirator medical monitoring protocol and been approved for the specific type of respirator to be used;
- Tight-fitting facepiece respirator (negative or positive pressure) users must have passed an appropriate fit test within past 12 months;
- Respirator use shall be limited to those activities identified in this plan. If site conditions change that alters the effectiveness of the specified respiratory protection, the RHSM shall be notified to amend the written plan;

- Tight-fitting facepiece respirator users shall be clean-shaven and shall perform a user seal check before each use;
- Canisters/cartridges shall be replaced at the end of each shift. Respirator users shall notify the SC or RHSM of any detection of vapor or gas breakthrough. The SC shall report any breakthrough events to the RHSM for schedule upgrade;
- Respirators in regular use shall be inspected before each use and during cleaning;
- Respirators in regular use shall be cleaned and disinfected as often as necessary to ensure they are maintained in a clean and sanitary condition;
- Respirators shall be properly stored to protect against contamination and deformation;
- Field repair of respirators shall be limited to routine maintenance. Defective respirators shall be removed from service;
- When breathing air is supplied by cylinder or compressor, the SC or RHSM shall verify the air meets Grade D air specifications; and
- The SC or designee shall complete the Self-Assessment Checklist – Respiratory Protection included in as attachment to this plan to verify compliance with CH2M HILL's respiratory protection program.

SECTION 15

Worker Training and Qualification

15.1 CH2M HILL Worker Training

(Reference CH2M HILL SOP HSE-110, *Training*)

15.1.1 Hazardous Waste Operations Training

All employees engaging in hazardous waste operations or emergency response shall receive appropriate training as required by 29 CFR 1910.120 and 29 CFR 1926.65. At a minimum, the training shall have consisted of instruction in the topics outlined in 29 CFR 1910.120 and 29 CFR 1926.65. Personnel who have not met these training requirements shall not be allowed to engage in hazardous waste operations or emergency response activities.

Initial Training

General site workers engaged in hazardous waste operations shall, at the time of job assignment, have received a minimum of 40 hours of initial health and safety training for hazardous waste site operations, unless otherwise noted in the above-referenced standards.

Employees who may be exposed to health hazards or hazardous substances at treatment, storage, and disposal (TSD) operations shall receive a minimum of 24 hours of initial training to enable the employee to perform their assigned duties and functions in a safe and healthful manner.

Employees engaged in emergency response operations shall be trained to the level of required competence in accordance with 29 CFR 1910.120.

Three-Day Actual Field Experience

General site workers for hazardous waste operations shall have received three days of actual experience (on-the-job training) under the direct supervision of a trained, qualified supervisor and shall be documented. If the field experience has not already been received and documented at a similar site, this supervised experience shall be accomplished and documented at the beginning of the assignment of the project.

Refresher Training

General site workers and TSD workers shall receive 8-hours of refresher training annually (within the previous 12-month period) to maintain qualifications for fieldwork. Employees engaged in emergency response operations shall receive annual refresher training of sufficient content and duration to maintain their competencies or shall demonstrate competency in those areas at least annually.

Eight-Hour Supervisory Training

On site management or supervisors who will be directly responsible for, or supervise employees engaged in hazardous waste site operations, will have received at least 8 hours of additional specialized training on managing such operations. Employees designated as Safety Coordinator – Hazardous Waste are considered 8-hour HAZWOPER Site Safety Supervisor trained.

15.1.2 First Aid/Cardiopulmonary Resuscitation

First aid and CPR training consistent with the requirements of a nationally recognized organization such as the American Red Cross Association or National Safety Council shall be administered by a certified trainer. A minimum of two personnel per active field operation will have first aid and CPR training. Bloodborne pathogen training located on CH2M HILL's Virtual Office is also required for those designated as first aid/CPR trained.

15.1.3 Safety Coordinator Training

SCs are trained to implement the HSE program on CH2M HILL field projects. A qualified SC is required to be identified in the site-specific HSP for CH2M HILL field projects. SCs must also meet the requirements of the worker category appropriate to the type of field project (construction or hazardous waste). In addition, the SCs shall have completed additional safety training required by the specific work activity on the project that qualifies them to implement the HSE program (for example, 30-hour OSHA Construction Safety Training, fall protection, excavation).

It is our intent to require site personnel designated with management, site supervisor, or SSHO responsibilities to have completed the 30hr OSHA Construction Safety Training and to maintain current American Red Cross or American Heart Association sponsored First Aid and Cardio-Pulmonary Resuscitation (FA-CPR) certifications. When a medical facility or physician is not accessible within 5 minutes of an injury to a group of two or more employees for treatment of injuries, at least two employees on each shift shall be trained to administer First Aid and CPR. These individuals have also been provided training in exercising universal precautions against exposure to blood borne pathogens as a component to FA/CPR training which meets the intent of 29CFR1910.1030. This employee training is also regularly complemented by other regularly scheduled employer training curriculums that are typically executed for the HAZWOPER industry, regulated under 29CFR1910.120/29CFR1926.26.

15.2 Procedures for Periodic Safety & Health Training

15.2.1 Site-Specific Training

Prior to commencement of field activities, all field personnel assigned to the project will have completed site-specific training that will address the contents of applicable HSPs, including the activities, procedures, monitoring, and equipment used in the site operations. Site-specific training will also include site and facility layout, potential hazards, risks associated with identified emergency response actions, and available emergency services. This training allows field workers to clarify anything they do not understand and to reinforce their responsibilities regarding safety and work operations for their particular activity.

15.2.2 Project-Specific Training Requirements

Project-specific training for this project includes:

- HSPs/AHAs

SECTION 16

Medical Surveillance and Qualification

All site workers participating in hazardous waste operations or emergency response will maintain an adequate medical surveillance program in accordance with 29 CFR 1910.120 or 29 CFR 1926.65 and other applicable OSHA standards. Documentation of employee medical qualification (e.g., physician's written opinion) will be maintained in the project files and made available for inspection.

16.1 Hazardous Waste Operations and Emergency Response

CH2M HILL personnel expected to participate in on site hazardous waste operations or emergency response are required to have a current medical qualification for performing this work. Medical qualification shall consist of a qualified physician's written opinion regarding fitness for duty at a hazardous waste site, including any recommended limitations on the employee's assigned work. The physician's written opinion shall state whether the employee has any detected medical conditions that would place the employee at increased risk of material impairment of the employee's health from work in hazardous waste operations or emergency response, or from respirator use.

Note: The medical surveillance program is performed by or directly supervised by a licensed physician board certified in occupational medicine.

16.2 Job or Site-Specific Medical Surveillance

Due to the nature of hazards for a particular job or work site, specialized medical surveillance may be necessary. This surveillance could include biological monitoring for specific compounds, or specialized medical examinations. Based on site conditions and COCs, specific medical surveillance is not required at this time. If air monitoring or analytical results indicate there could be exposure to contaminants above action levels, this plan will be modified.

16.3 Respirator User Qualification

Personnel required to wear respirators must have a current medical qualification to wear respirators. Medical qualification shall consist of a qualified physician's written opinion regarding the employee's ability to safely wear a respirator in accordance with 29 CFR 1910.134.

16.4 Hearing Conservation

Personnel working in hazardous waste operations or operations that fall under 29 CFR 1910.95 and exposed to noise levels in excess of the 85dBA time-weighted average shall be included in a hearing conservation program that includes annual audiometric testing.

SECTION 17

Site-Control Plan

17.1 Site-Control Procedures

(Reference CH2M HILL SOP HSE-218, *Hazardous Waste Operations)*

Site control is established to prevent the spread of contamination throughout the site and to ensure that only authorized individuals are permitted into potentially hazardous areas.

The SC will implement site control procedures including the following bulleted items.

- Establish support, contamination reduction, and exclusion zones. Delineate with flags or cones as appropriate. Support zone should be upwind of the site. Use access control at entry and exit from each work zone.
- Establish onsite communication consisting of the following:
  - Line-of-sight and hand signals;
  - Air horn; and
  - Two-way radio or cellular telephone if available.
- Establish offsite communication.
- Establish and maintain the "buddy system."

17.2 Remediation Work Area Zones

(Reference CH2M HILL SOP HSE-218 Hazardous Waste Operations)

A three-zone approach will be used to control areas where site contaminants exist. Access will be allowed only after verification of appropriate training and medical qualification. The three-zone approach shall include an EZ, Contamination Reduction Zone (CRZ) and a Support Zone (SZ). The three-zone approach is not required for construction work performed outside contaminated areas where control of site contamination is not a concern.

Specific work control zones shall be established as necessary during task planning. Site work zones should be modified in the field as necessary, based on such factors as equipment used, air monitoring results, environmental conditions, or alteration of work plans. The following guidelines shall be used for establishing and revising these preliminary zone designations.

17.2.1 Support Zone

The SZ is an uncontaminated area (trailers, offices, field vehicles, etc.) that will serve as the field support area for most operations. The SZ provides field team communications and staging for emergency response. Appropriate sanitary facilities and safety and emergency response equipment will be located in this zone. Potentially contaminated personnel/materials are not allowed in this zone. The only exception will be appropriately packaged and decontaminated materials, or personnel with medical emergencies that cannot be decontaminated.

17.2.2 Contamination Reduction Zone

The CRZ is established between the EZ and the SZ, upwind of the contaminated area where possible. The CRZ provides an area for decontamination of personnel, portable handheld equipment and tools, and heavy equipment. In addition, the CRZ serves as access for heavy equipment and emergency support services.

17.2.3 Exclusion Zone

The EZ is where activities take place that may involve exposure to site contaminants and/or hazardous materials or conditions. This zone shall be demarcated to prevent unauthorized entry. More than one EZ may be established if there are different levels of protection to be employed or different hazards that exist in the same work area. The EZ shall be large enough to allow adequate space for the activity to be completed, including field personnel and equipment, as well as necessary emergency equipment.

The EZ shall be demarcated with some form of physical barrier or signage. The physical barrier or signage shall be placed so that they are visible to personnel approaching or working in the area. Barriers and boundary markers shall be removed when no longer needed.

17.2.4 Other Controlled Areas

Other work areas may need to be controlled due to the presence of an uncontrolled hazard, to warn workers of requirements, or to prevent unauthorized entry. Examples include general construction work areas, open excavations, high noise areas, vehicle access areas, and similar activities or limited access locations. These areas shall be clearly demarcated with physical barriers (fencing, cones, reinforced caution tape or rope) as necessary and posted with appropriate signage.

Only individuals who meet the requirements of 29 CFR 1910.120/29CFR1926.65 and who are authorized by the CH2MHILLsite supervisor or SSHO shall be allowed entry into the EZ and CRZ. Suitable means and methods (high visibility fencing, caution tape signage, other physical barriers) shall be employed to demarcate the EZ and CRZ boundaries at this site to prevent unauthorized entry into these controlled work zones. A CRZ for decontamination shall be established adjacent to the EZ. The SZ shall be kept free from contamination. Personnel entering the EZ/CRZ will be required to log-in/log out on a daily basis.

SECTION 18

Decontamination

(Reference CH2M HILL SOP HSE-218, *Hazardous Waste Operations*)

Decontamination areas will be established for work in potentially contaminated areas to prevent the spread of contamination. Decontamination areas should be located upwind of the exclusion zone where possible and should consider any adjacent or nearby projects and personnel. The SC must establish and monitor the decontamination procedures and their effectiveness. Decontamination procedures found to be ineffective will be modified by the SC. The SC must ensure that procedures are established for disposing of materials generated on the site.

No eating, drinking, or smoking is permitted in contaminated areas and in exclusion or decontamination zones. The SC should establish areas for eating, drinking, and smoking.

18.1 Contamination Prevention

Preventing or avoiding contamination of personnel, tools, and equipment will be considered in planning work activities at all field locations. Good contamination prevention and avoidance practices will assist in preventing worker exposure and result in a more efficient decontamination process. Procedures for contamination prevention and avoidance include the following:

- Do not walk through areas of obvious or known contamination;
- Do not directly handle or touch contaminated materials;
- Make sure there are no cuts or tears in PPE;
- Fasten all closures in suits and cover them with duct tape, if appropriate;
- Take particular care to protect any skin injuries;
- Stay upwind of airborne contamination, where possible;
- Do not eat or drink in contaminated work areas;
- Do not carry food, beverages, tobacco, or flame-producing equipment into contaminated work areas;
- Minimize the number of personnel and amount of equipment in contaminated areas to that necessary for accomplishing the work;
- Choose tools and equipment with nonporous exterior surfaces that can be easily cleaned and decontaminated;
- Cover monitoring and sampling equipment with clear plastic, leaving openings for the sampling ports, as necessary; and
- Minimize the amount of tools and equipment necessary in contaminated areas.

18.2 Personnel and Equipment Decontamination

Personnel exiting an EZ must ensure that they are not spreading potential contamination into clean areas or increasing their potential for ingesting or inhaling potential contaminants. Personal decontamination may range from removing outer gloves as exiting the EZ, to proceeding through an outer layer doffing station including a boot and glove wash and rinse, washing equipment, etc. Equipment that has come into contact with contaminated media must also be cleaned/decontaminated when it is brought out of the EZ.

18.3 Decontamination During Medical Emergencies

Standard personnel decontamination practices will be followed whenever possible. For emergency life saving first aid and/or medical treatment, normal decontamination procedures may need to be abbreviated or omitted. In this situation, site personnel shall accompany contaminated victims to advise emergency response personnel on potential contamination present and proper decontamination procedures.

Outer garments may be removed if they do not cause delays, interfere with treatment, or aggravate the problem. Protective clothing can be cut away. If the outer garments cannot be safely removed, a plastic barrier between the individual and clean surfaces should be used to help prevent contaminating the inside of ambulances or medical personnel. Outer garments can then be removed at the medical facility.

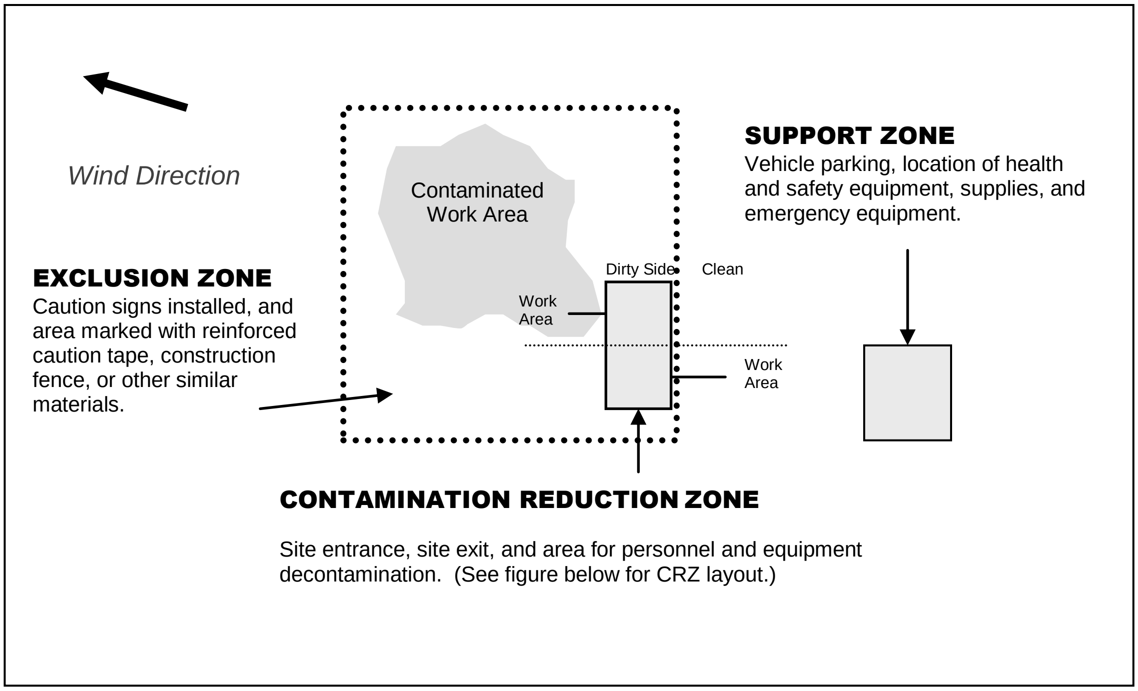
18.4 Waste Collection and Disposal

All contaminated material generated through the personnel and equipment decontamination processes (e.g., contaminated disposable items, gross debris, liquids, sludges) will be properly containerized and labeled, stored at a secure location, and disposed in accordance with the project plans.

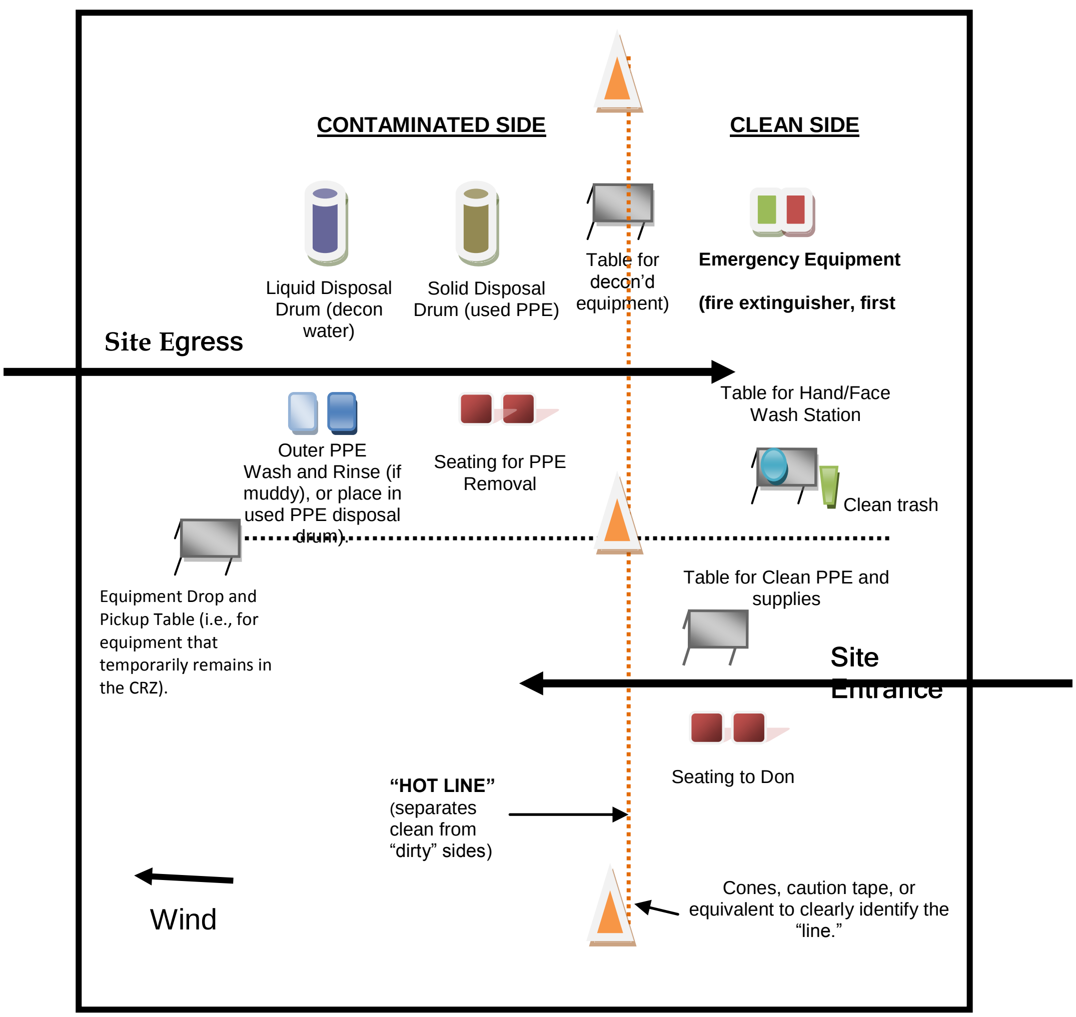
18.5 Diagram of Personnel-Decontamination Line

The following figure illustrates a conceptual establishment of work zones, including the decontamination line. Work zones are to be modified by the SC to accommodate task-specific requirements.

Work Area - Set up appropriately based on wind direction



Typical Contamination Reduction Zone



SECTION 19

Emergency Response Plan

(Reference CH2M HILL SOP HSE-106, *Emergency Planning*)

19.1 Pre-Emergency Planning

(Reference CH2MHILL SOP # HSE&Q 106, Emergency Planning)

The site SSC performs the applicable pre-emergency planning tasks before starting field activities and coordinates emergency response with identified on-site parties, the NWSY POCs, and local emergency-service providers, as necessary. These pre-emergency planning activities include the following:

- Determine what onsite communication equipment is needed and readily available (e.g., two-way radio, air horn, non-camera enabled cell phones).
- Verifying that the “Buddy System” will and is being used for all assigned work unless “working alone” is allowed and the working alone protocol is implemented.
- Confirm and post emergency telephone numbers, evacuation routes, assembly areas, and route to hospital; communicate the information to onsite personnel. Posting of emergency contact information shall be posted in a commonly accessed area in clear view of the on-site workers.
- Review any potential changed site or onsite operating conditions from that which was planned.
- Where appropriate and acceptable to the client, inform emergency room and ambulance and emergency response teams of anticipated types of site emergencies. Determine host facility emergency response procedures and availability of emergency response personnel.
- Designate one vehicle as the emergency vehicle; place hospital directions and map inside; keep keys in ignition during field activities.
- Inventory and check site emergency equipment, supplies, and potable water.
- Communicate emergency procedures for personnel injury, exposures, fires, explosions, and releases.
- Rehearse the emergency response plan before site activities begin, including driving route to hospital.
- Brief new workers on the components of the HSP and emergency response plan.

19.1.1 Emergency Equipment and Supplies

The site SSC shall verify the availability and readiness of emergency support equipment listed below.

Emergency Equipment and Supplies	Location
20 LB (or two 10-lb) fire extinguisher (A, B, and C classes) w/ annual maintenance and monthly inspection tags	Support Area
First aid kit/CPR Shield	Support Area
Eye Wash Kit (Bottles)	Support Area
Potable water	Support Area
Blood borne-pathogen kit	Support Area
Additional equipment (specify): Mobile phone and contact information	Support Area for site supervisor, site management & SSHO at a minimum
Spill Control/Clean-up Materials/Proper Spill Response PPE	Support Area

19.1.2 Evacuation

The Site Supervisor/FTL or SSHO will direct the coordination of response to emergency actions or medical support situations at the project site location. Response considerations include the following elements:

a) **Adhere to any NWSY specific evacuation procedures, notification requirements or response procedures if emergency conditions should occur.**

b) Evacuation routes and assembly areas will be specified at the commencement of field work. Evacuation route(s) and assembly area(s) will be designated by the site supervisor or SSC before work begins and posted at the designated evacuation rally point or construction support facility.

c) Personnel shall be advised of the assembly and accounting process during emergency conditions, able to understand evacuation signals and know where final evacuation assembly areas are located. The site supervisor or SSHO will account for personnel assembly area(s).

d) Designation of a vehicle to be available to support emergency conditions or response actions.

e) Evaluation of existing and potential hazards that may be associated with any experienced emergency condition and mitigation measures necessary to control hazards so the response measures can be executed without additional danger.

f) Assessment of the situation and condition of any victims.

g) Determination of the resources needed for victim stabilization and transport and additional emergency support.

h) Enforcement of the Buddy System. No one will be permitted to perform a response to an emergency condition alone.

i) Removal of injured personnel from the area and/or control of the emergency condition.

j) Decontamination of injured parties will be accomplished after stabilization of their medical conditions, where necessary. Gross decontamination maybe required if their condition poses immediate threat to the victim's life. If decontamination may cause additional harm to an injured person, then alternate measures such as wrapping the injured person in material to prevent the spread of contamination during extrication and transport may be required. In this situation, emergency medical transport personnel and the receiving medical facility must be advised of potential contamination issues of injured personnel, as early as possible.

Signal	Meaning
Grasping throat with hand	Emergency-help me.
Thumbs up	OK; understood.
Grasping buddy’s wrist	Leave area now.
Continuous sounding of vehicle horn/air horn **(Verify signal does not coincide with evacuation signals for government personnel in close proximity to the site)**	Emergency; leave site now.
“Air raid”-type siren	Leave site immediately
Severe Weather Warnings (radio, TV, internet)	Leave the region in accordance with the facility and/or regional evacuation orders or directives from program/project management team

This evacuation route map provide as Figure 19-1 below, could be used for evacuations due to pending severe weather conditions, site emergency or in the event that the sites were being evacuated and secured due to a to a national or regional emergency.

FIGURE 19-1:
Site Evacuation Route

When an emergency evacuation signal is given or required, all site personnel shall shut down operations and equipment, complete any personnel decontamination procedures, secure the site to the extent possible, account for all site personnel and proceed to the evacuation assembly area. Site personnel shall contact the CH2MHILL management team in accordance with the “Incident Reporting Process and Chain of Command” via the contact numbers contained in the “Emergency Contact List” of this HSP. Site personnel shall secure further instructions from the NWSY POCs in order to continue with evacuation procedures, as needed.

19.1.3 Procedures and Tests

It is the intention of the project team to verify that emergency response processes are in place and capable of being executed, prior to the start of field assignments. However, because of the nature of the facility, response to medical or fire emergencies will likely be supported by NWSY or potentially by outside public responders with secured or escorted access. As such, it may be impractical and disruptive to the primary mission of these responders to perform “procedural response testing”. In this case, the designated site supervisor or SSC shall verify that emergency services are available for response, that contact information is appropriate, and that responders know how to access anticipated work areas.

19.1.4 Spill Plans

The initial response to any spill or discharge will be to protect human health and safety, and then the environment. Identification, containment, treatment, and disposal assessment will be the secondary response.

If for some reason a chemical spill is not contained, but inherent process, contained within a dike or sump area, an area of isolation must be established around the spill. The size of the area will generally depend on the size of the spill AND the materials involved. If the spill is large (greater than 55 gallons) and involves a tank or a pipeline rupture, an initial isolation of at least 100 feet in all directions should be used, depending on the hazards posed by the spilled or released material. Small spills (less than or equal to 55 gallons) or leaks from a tank or pipe, depending on the hazards posed by the spilled or released material, will require evacuation of at least 50 ft in all directions to allow cleanup and repair and to prevent exposure. When any spill occurs, only those persons involved in overseeing or performing emergency operations will be allowed within the designated hazard area and must maintain appropriate training, and be enrolled in a medical surveillance program in accordance with the requirements of 29CFR1910.120/29CFR1926.65 and possess proper experience and PPE, to do so. If possible, the area will be roped off or otherwise blocked to provide restricted access to authorized personnel only.

If the spill results in the formation of a toxic vapor cloud (by reaction with surrounding materials or by outbreak of fire) or creates a “toxic” or Immediately Dangerous to Life and Health situation then further evacuation and response procedures must be engaged. In general, an area at least 500 feet wide and 1,000 feet long will be evacuated downwind if volatile materials are spilled. (Consult the Department of Transportation (DOT) Emergency Response Guide for isolation distances for listed hazardous materials.)

If an incident may threaten the health or safety of the surrounding community, the public will be informed (via proper local and state emergency management planning agencies) and possibly evacuated from the area. The onsite emergency coordinator will inform the proper NWSY POCs in the event this is necessary. A project Emergency Contact List is provided in this HSP. However, for the proposed work at NWSY, it is our understanding that such chemicals or materials that could create such a situation are not present on site, nor will CH2MHILL bring such materials on-site as part of its scheduled work.

Reporting of spills or releases of oil or hazardous materials to appropriate agencies and stakeholders (i.e. NAVFAC, EPA, State DEP, the LECA etc.) must be reported when spilled or released quantities of oil or hazardous materials are in excess of established Reportable Quantities (RQs) for the material in questions.

In a spill or release response/containment, personnel shall take the following measures:

- Immediately warn any nearby workers and notify individual responsible for site operations.
- Assess the spill area to ensure that it is safe to respond.
- Evacuate area if spill presents an emergency.
- Provide notification to project stakeholders.
- Ensure all unnecessary persons are removed from the hazard area.
- Put on protective clothing and equipment.

- If a flammable material is involved, remove all ignition sources, and use only spark- and explosion-proof equipment for recovery of material.
- Remove all surrounding materials that could be especially reactive with materials in the waste. Determine the major components in the waste at the time of the spill.
- Stop source of spill and establish site control for spill area.
- If wastes reach a storm sewer, dam the outfall by using sand, earth, sandbags, etc. Pump this material out into a temporary holding tank or drums as soon as possible.
- Place all small quantities of recovered liquid wastes (55 gallons or less) and contaminated soil into drums for incineration or removal to an approved disposal site.
- Spray the spill area with foam, if available, if volatile emissions may occur.
- Apply appropriate spill control media (e.g., clay, sand, lime) to absorb discharged liquids.
- For large spills, establish diking around leading edge of spill using booms, sand, clay, or other appropriate material. If possible, use diaphragm pump to transfer discharged liquid to drums or holding tank. Follow proper ground and bonding procedures of equipment during recovery efforts. Intrinsically safe equipment must be used in recovery operations.

  For small fires or chemical releases, actions to be taken include the following:

  1. Shut down operations and evacuate the immediate work area
  2. Notify appropriate response personnel
  3. Account for personnel at the designated assembly area(s)
  4. Assess the need for site evacuation, and evacuate the site as warranted

Instead of implementing a work-area evacuation, small fires or spills posing minimal safety or health hazards may be controlled by onsite personnel, assuming that personnel who respond to these emergencies are properly trained to do so and wearing appropriate PPE to protect themselves against hazards that may be associated with the response.

In addition to the above, CH2MHILL will have project field staff that are trained in accordance with 29CFR1910.120, are enrolled in a medical surveillance program meeting the criteria of 29CFR1910.120(f) and have previous experience training to mitigate unanticipated small releases of materials that could occur on this project (i.e. Petroleum, Oil or Lubricants) with heavy equipment and spill materials that will be readily available at the project site.

Anticipated Hazardous Materials

The following is a list of hazardous materials or chemicals that may be brought on-site and incorporated as part of the final completion of the work, generated during the execution of the work for offsite disposal or recycling or otherwise used to facilitate site work. These hazardous materials or chemicals may require spill prevention and countermeasure control processes to ensure sensitive environmental receptors are not adversely impacted in the event of a spill or release of these materials.

- Impacted ground water or LNAPL generated during ground water well/extraction well installations, development/sampling events and pumping tests operations.
- Decontamination fluids generated during from drilling operations.
- Impacted soil generated during soil boring/ground water well installation operations.

Notification

In the event a spill occurs that requires notification, a project person shall follow the "POCs and emergency contacts listed in **Section 18.5** of this HSP.

In addition, the CH2MHILL Project Manager shall make notification to the designated project NWSY POC and environmental compliance representative(s) or other designated NAVFAC personnel, such that additional appropriate community and/or federal/state agencies may be engaged and notified, if applicable. The CH2MHILL Project Manager shall coordinate with the designated project NAVFAC POC for support with regard to adhering to local, state, or federal regulations for spill notification clean-up and closure requirements.

19.1.5 Firefighting Plan

CH2MHILL personnel are not considered Firefighting Organizations or Fire Brigades and are not authorized to “fight fires”. Only “small” incipient stage fires that are containable by the use of first response fire protection equipment (i.e. 2.5 to 10 lb ABC fire extinguishers) may be controlled by CH2MHILL personnel. All other response shall be considered firefighting measures and shall be conducted by NWSY or local agency firefighting teams.

Fire prevention measures and first response fire protection equipment shall be conducted in accordance with the information identified in this HSP.

19.1.6 Posting of Emergency Telephone Numbers

Emergency contact numbers appropriate to project operations are included in **Section 18.5** of this HSP and are referenced as the “Emergency Contact List”. For this project it is anticipated that a temporary project construction support trailer will not be mobilized to the project at any time during anytime. Due to the relatively short duration and infrequent and discontinuous nature of field operations associated with this project, the requirement for posting of emergency contact information shall be met by the use of and on-site project folder system at can be accessed by on-site workers. This action shall be considered as meeting the intent of EM 385 1-1, 01.A.06 and 01.E.05.

19.1.7 Man Overboard / Abandon Ship

(Reserved)

There are no conditions were site personnel will be working aboard ships or other water vessels during the execution of this task order.

19.1.8 Medical Support

Location and direction to medical support facilities shall be posted in a conspicuous location where temporary construction facilities or support are established at the project site. Where temporary construction facilities or a designated administrative/support office are not allowed or provided, the list shall be available for quick reference by site supervisor/FTL or SSC personnel executing site operations and its location shall also be made known to other site personnel.

In addition, the project shall be outfitted with first aid kits of suitable size and quality (contents) to meet health and safety requirements for on-site first aid and CPR response. Personal protective devices shall be provided such that universal precautions against blood borne pathogens can be exercised while administering CPR or first aid. Eye wash stations, either portable or stationary, will be available.

An effective means of communication and to summon transportation of injured workers to medical treatment facilities must be evaluated and established prior to the start of field activities. Communication devices shall be tested in the area of use to assure functionality. When a medical facility or physician is not accessible within five (5) minutes of an injury to a group of two or more employees for the treatment of injuries, at least two (2) employees on each shift shall be qualified to administer first-aid and CPR.

It must be understood that for life threatening emergencies, get or summon medical attention immediately.

- During non-emergencies, follow these procedures as appropriate.
- Notify appropriate emergency response authorities (e.g., 911).
- The site supervisor or SSC will assume charge during a medical emergency until the ambulance arrives or until the injured person is admitted to the emergency room.

- Prevent further injury.
- Initiate first aid and CPR where feasible and where worker "Universal Precautions" to Blood borne Pathogens can be completed.
- Perform decontamination where feasible; lifesaving and first aid or medical treatment take priority.
- Make certain that the injured person is accompanied to the emergency room.
- When contacting the medical consultant, give your name and telephone number, the name of the injured person, the extent of the injury or exposure, and the name and location of the medical facility where the injured person was taken.
- **A map showing the route to the local hospital in the area Figures 18-2.**

FIGURE 19-2: Hospital Route Map

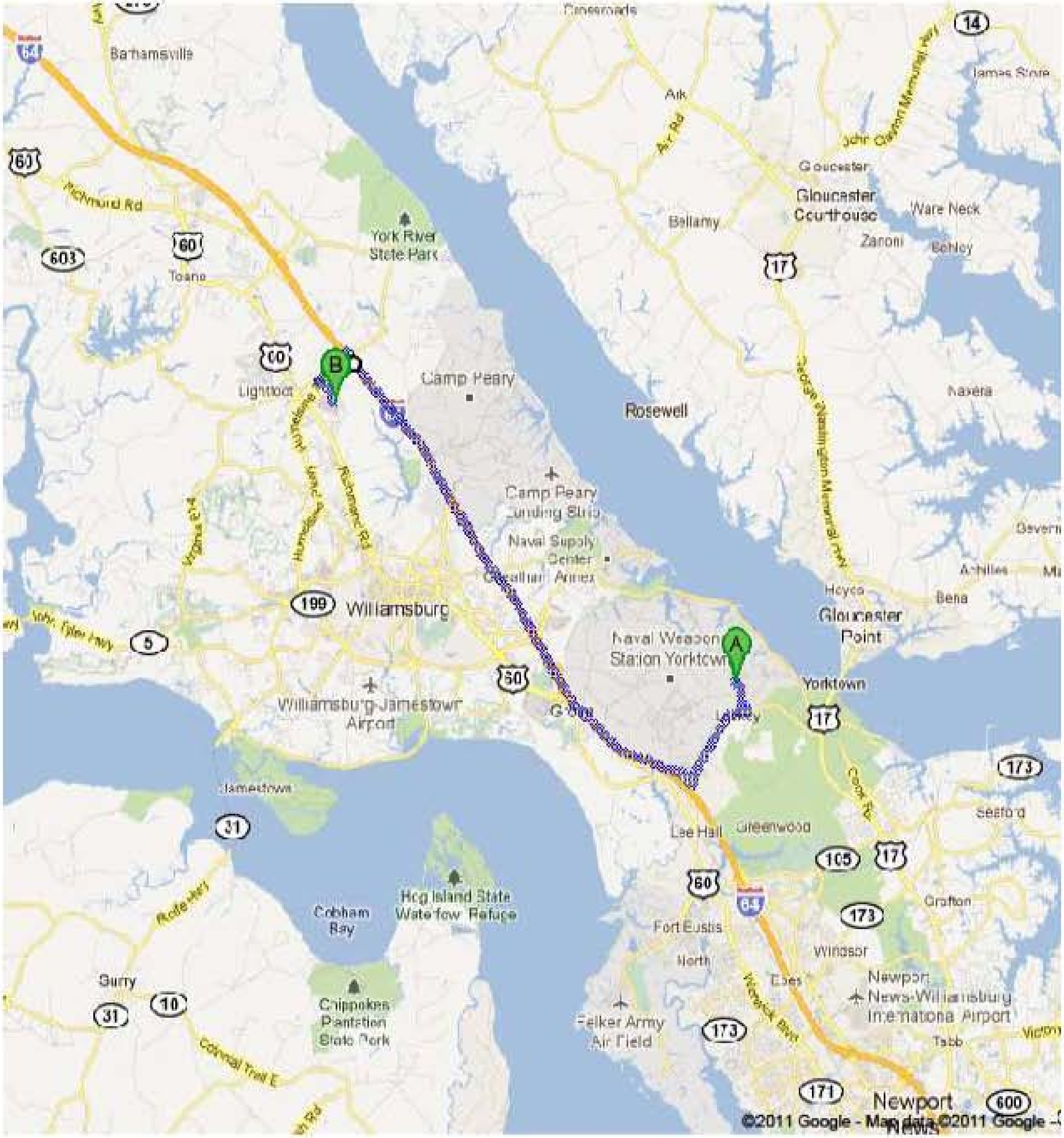
Local Hospital

Hospital Name/Address: Sentara Williamsburg Regional Medical Center
100 Sentara Circle, Williamsburg, VA 23188

Hospital Phone # (757) 984-6000

Head south on Bollman Rd toward Spring Rd	0.4 mi
Turn left toward Main Rd	0.2 mi
Take the 1st right onto Main Rd	259 ft
Take the 1st right onto VA-238 W/Old Williamsburg Rd Continue to follow VA-238 W	2.4 mi
Turn right toward Jefferson Ave	125 ft
Turn right onto Jefferson Ave	0.8 mi
Merge onto I-64 W via the ramp to Williamsburg/Richmond	12.8 mi
Take exit 234A to merge onto VA-199 E/Humelsine Pkwy E/Newman Rd/State Route 646 toward Lightfoot Continue to follow VA-199 E/Humelsine Pkwy E	1.2 mi
Take the exit toward VA-603 E/Mooretown Rd/Rochambeau Dr	0.2 mi
Merge onto Mooretown Rd	0.4 mi
Turn right onto Sentara Cir	0.2 mi
Turn right Destination will be on the right	0.1 mi

CH2MHILL Project – Emergency Contacts
Sid


Barhamsville
Richmond Rd
York River State Park
Toano
Lightfoot
Camp Peary
Camp Peary Landing Strip
Naval Supply Center
Cheatham Annex
Williamsburg
Williamsburg-Jamestown Airport
Naval Weapon Station Yorktown
Rosewell
Gloucester
Gloucester Courthouse
Ware Neck
Bellamy
Zanoni
Gloucester Point
Yorktown
Jamestown
Lee Hall
Greenwood
Hog Island State Waterfowl Refuge
Cobham Bay
Fort Eustis
Surry
Chippokes Plantation State Park
Felker Army Air Field
Newport News-Williamsburg International Airport
Newport News
Grafton
Seaford
Windsor
Tabb
Achilles
Bena
Naxera
James Store
Ark
Crossroads
©2011 Google - Map data ©2011 Google

19.2 Emergency Equipment and Supplies

The ERC should mark the locations of emergency equipment on the site map and post the map.

Emergency Equipment and Supplies	Location
20 (or two 10) class A,B,C fire extinguisher	Field Vehicle
First aid kit	Field Vehicle
Eye Wash	Field Vehicle
Potable water	Field Vehicle
Bloodborne-pathogen kit	Field Vehicle
Additional equipment (specify): Cell Phone	FTL/SSC

19.3 Incident Response

In fires, explosions, or chemical releases, actions to be taken include the following:

- Notify appropriate response personnel.
- Shut down CH2M HILL operations and evacuate the immediate work area.
- Account for personnel at the designated assembly area(s).
- Assess the need for site evacuation, and evacuate the site as warranted.
- Implement HSE-111, Incident Notification, Reporting and Investigation.
- Notify and submit reports to clients as required in contract.

Small fires or spills posing minimal safety or health hazards may be controlled with onsite spill kits or fire extinguishers without evacuating the site. When in doubt evacuate. Follow the incident reporting procedures in the “Incident Notification, Reporting, and Investigation” section of this HSP.

19.4 Emergency Medical Treatment

Emergency medical treatment is needed when there is a life-threatening injury (such as severe bleeding, loss of consciousness, breathing/heart has stopped). When in doubt if an injury is life-threatening or not, treat it as needing emergency medical treatment.

- Notify 911 or other appropriate emergency response authorities as listed in the “Emergency Contacts” page located in this section.
- The ERC will assume charge during a medical emergency until the ambulance arrives or until the injured person is admitted to the emergency room.
- Prevent further injury, perform decontamination (if applicable) where feasible; lifesaving and first aid or medical treatment takes priority.
- Initiate first aid and CPR where feasible. First aid and CPR training consistent with the requirements of a nationally recognized organization such as the American Red Cross Association or National Safety Council shall be administered by a certified trainer. A minimum of two personnel per active field operation will have first aid and CPR training. Bloodborne pathogen training located on CH2M HILL’s Virtual Office is also required for those designated as first aid/CPR trained.
- Notify supervisor and if the injured person is a CH2M HILL employee, the supervisor will call the worker’s immediate supervisor and make other notifications as required by HSE SOP-111, *Incident Notification, Reporting and Investigation*.

- Make certain that the injured person is accompanied to the emergency room.
- Follow the Serious Incident Reporting process in HSE SOP-111, Incident Notification, Reporting and Investigation, and complete incident report using the HITS system on the Virtual Office or if not feasible, use the hard copy forms provided as an attachment to this HSP.
- Notify and submit reports to client as required in contract.

19.5 Inclement Weather

Sudden inclement weather can rapidly encroach upon field personnel. Preparedness and caution are the best defenses. Field crew members performing work outdoors should carry clothing appropriate for inclement weather. Personnel are to take heed of the weather forecast for the day and pay attention for signs of changing weather that indicate an impending storm. Signs include towering thunderheads, darkening skies, or a sudden increase in wind. If stormy weather ensues, field personnel should discontinue work and seek shelter until the storm has passed.

Protective measures during a lightning storm include seeking shelter; avoiding projecting above the surrounding landscape (don't stand on a hilltop--seek low areas); staying away from open water, metal equipment, railroad tracks, wire fences, and metal pipes; and positioning people several yards apart. Some other general precautions include:

- Know where to go and how long it will take to get there. If possible, take refuge in a large building or vehicle. Do not go into a shed in an open area.
- The inclination to see trees as enormous umbrellas is the most frequent and most deadly mistake. Do not go under a large tree that is standing alone. Likewise, avoid poles, antennae and towers.
- If the area is wide open, go to a valley or ravine, but be aware of flash flooding.
- If you are caught in a level open area during an electrical storm and you feel your hair stand on end, drop to your knees, bend forward and put your hands on your knees or crouch. The idea is to make yourself less vulnerable by being as low to the ground as possible and taking up as little ground space as possible. Lying down is dangerous, since the wet earth can conduct electricity. Do not touch the ground with your hands.
- Do not use telephones during electrical storms, except in the case of emergency

Remember that lightning may strike several miles from the parent cloud, so work should be stopped/restarted accordingly. The lightning safety recommendation is 30-30: Seek refuge when thunder sounds within 30 seconds after a lightning flash; and do not resume activity until 30 minutes after the last thunder clap.

High winds can cause unsafe conditions, and activities should be halted until wind dies down. High winds can also knock over trees, so walking through forested areas during high-wind situations should be avoided. If winds increase, seek shelter or evacuate the area. Proper body protection should be worn in case the winds hit suddenly, because body temperature can decrease rapidly.

Emergency Contacts

24-hour CH2M HILL Serious Incident Reporting Contact – 720-286-4911

If injured on the job, notify your supervisor and then call 1-866-893-2514 to contact CH2M HILL'S Occupational Nurse

Medical Emergency – **Facility Medical Response #:** 757-444-3333 **Branch Medical Clinic Ambulance #:** 7-4911 (on-station phone) (757)887-4911 (off-station phone) **Public Ambulance #:** 911	**CH2M HILL- Medical Consultant** WorkCare Dr. Peter Greaney M.D. 300 S. Harbor Blvd, Suite 600 Anaheim , CA 92805 866.893.2514 714-978-7488
Fire/Spill Emergency -- **Facility Fire and Spill Response #:** 757-444-3333	**CH2M HILL Director – Health, Safety, Security & Environment** Andy Strickland/DEN 720-480-0685 (cell) or 720-286-2393 (office)
Security & Police – Facility Security #: 757-444-2324	**CH2M HILL Responsible Health and Safety Manager (RHSM)** Name: Mark Orman Phone: 414-847-0597
Utilities Emergency: Water: Call Miss Utility 800-552-7001 Gas: Call Miss Utility 800-552-7001 Electric: Call Miss Utility 800-552-7001	**CH2M HILL Human Resources Department** Name: Sherri Huntley Phone: 703-376-5192
CH2M HILL Project Manager Name: Mary Anderson Phone:+1 (518) 982-0572	**CH2M HILL Worker's Compensation:** Contact Business Group HR dept. to have form completed or contact Jennifer Rindahl after hours: 720-891-5382
CH2M HILL Safety Coordinator (SC) Name: Mark Ost Phone: 757-671-6247	**Media Inquiries Corporate Strategic Communications** Name: John Corsi Phone: 720-286-2087
CH2M HILL Project Environmental Manager Name: Hope Oaks Phone:678- 530-4226	**Automobile Accidents** Rental: Jennifer Rindahl/DEN: 720-286-2449 CH2M HILL owned vehicle: Linda George/DEN: 720-286-2057
Federal Express Dangerous Goods Shipping Phone: 800-238-5355	**CHEMTEL (hazardous material spills)** **Phone: 800-255-3924**
Facility Alarms: TBD by SSC	Evacuation Assembly Area(s): TBD by SSC

Facility/Site Evacuation Route(s): TBD by SSC

Local Hospital Name/Address:

Sentara Williamsburg Regional Medical Center
100 Sentara Circle, Williamsburg, VA 23188

Hospital Phone # (757) 984-6000

Refer to directions and map above.

SECTION 20
Spill Containment Procedures

CH2M HILL and subcontractor personnel working at the project site shall be knowledgeable of the potential health, safety and environmental concerns associated with petroleum and other substances that could potentially be released at the project site.

The following is a list of criteria that must be addressed in CH2M HILL's or the subcontractor's plans in the event of a spill or release. In the event of a large quantity spill notify emergency services. Personnel discovering a spill shall (only if safe to do so):

- Stop or contain the spill immediately (if possible) or note source. Shut off the source (e.g., pump, treatment system) if possible. If unsafe conditions exist, leave the area, call emergency services, inform nearby personnel, notify the site supervisors, and initiate incident reporting process. The SC shall be notified immediately;
- Extinguish sources of ignition (flames, sparks, hot surfaces, cigarettes);
- Clear personnel from the spill location and barricade the area;
- Use available spill control equipment in an effort to ensure that fires, explosions, and releases do not occur, recur, or spread;
- Use sorbent materials to control the spill at the source;
- Construct a temporary containment dike of sorbent materials, cinder blocks, bricks or other suitable materials to help contain the spill;
- Attempt to identify the character, exact source, amount, and extent of the released materials. Identification of the spilled material should be made as soon as possible so that the appropriate cleanup procedure can be identified;
- Assess possible hazards to human health or the environment as a result of the release, fire or explosion; and
- Follow incident notification, reporting, and investigation section of this plan.

SECTION 21
Inspections

21.1 Project Activity Self-Assessment Checklists

In addition to the hazard controls specified in this document, Project Activity Self-Assessment Checklists are contained as an attachment to this HSP. The Project-Activity Self–Assessment Checklists are based upon minimum regulatory compliance and some site-specific requirements may be more stringent. The objective of the self-assessment process is to identify gaps in project safety performance, and prompt for corrective actions in addressing these gaps. The self-assessment checklists, including documented corrective actions, shall be made part of the permanent project records and maintained by the SC.

The self-assessment checklists will also be used by the SC in evaluating the subcontractors and any client contractors' compliance on site.

The self-assessment checklists for the following tasks and exposures are required when the task or exposure is initiated and weekly thereafter while the task or exposure is taking place. The checklists shall be completed by the SC or other CH2M HILL representative and maintained in project files.

- Drilling
- Hand and Power Tools
- Electrical Safety
- Traffic Control
- PPE

21.2 Safe Behavior Observations

Safe Behavior Observations (SBOs) are a tool to be used by supervisors to provide positive reinforcement for work practices performed correctly, while also identifying and eliminating deviations from safe work procedures that could result in a loss.

The SC or designee shall complete SBO form (attached to this HSP) minimum of one per week. They shall be electrically submitted weekly by e-mailing them to the Federal Sector email address on bottom of form.

SECTION 22

Incident Notification, Reporting, and Investigation

(Reference CH2M HILL SOP HSE-111, *Incident Notification, Reporting and Investigation*)

22.1 General Information

This section applies to the following:

- All injuries involving employees, third parties, or members of the public
- Damage to property or equipment
- Interruptions to work or public service (e.g., hitting a utility)
- Incidents which attract negative media coverage
- Near misses
- Spills, leaks, or regulatory violations
- Motor vehicle accidents

Documentation, including incident reports, investigation, analysis and corrective measure taken, shall be kept by the SC and maintained onsite for the duration of the project.

22.2 Section Definitions

Incident: an undesired event which results or could have resulted in loss through injury, damage to assets or environmental harm. This includes all of the definitions below.

Accident: an incident involving actual loss through injury, damage to assets, or environmental harm.

Near Miss: an unsafe act or incident which, in other circumstances, could have resulted in loss through injury, damage to assets, or environmental harm.

Serious Incident:

- All fatalities including contractors, subcontractors, third parties, or members of the public
- Kidnap/Missing Person
- Event that involves a fire, explosion, or property damage that requires a site evacuation or is estimated to result in greater than $ 500,000 in damage.
- Acts or threats of terrorism
- Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment.

22.3 Reporting Requirements

All employees and subcontractors' employees shall immediately report any incident (including "near misses," as defined in the section above) in which they are involved or witness to their supervisor.

The CH2M HILL or Subcontractor supervisor, upon receiving an incident report, shall inform his immediate superior and the CH2M HILL SC.

The SC shall immediately report the following information to the RHSM and PM by phone and e-mail:

- Project Name/Site Manager
- Date and time of incident
- Description of incident

- Extent of known injuries/damage
- Level of medical attention
- Preliminary root cause/corrective actions

The SC shall complete an entry into the Hours and Incident Tracking System (HITS) database system located on CH2M HILL's Virtual Office (or if VO not available, use the hard copy Incident Report Form and Root Cause Analysis Form and forward it to the RHSM) within 24 hours and finalize those forms within 3 calendar days.

The CH2M HILL team shall comply with all applicable statutory incident reporting requirements such as those to OSHA and the police.

22.4 HITS System and Incident Report Form (IRF)

It is the policy of CH2M HILL to maintain a HITS entry and/or Incident Report Form (IRF) for all work-related injuries and illnesses sustained by its employees in accordance with recordkeeping and insurance requirements. A HITS entry and/or IRF will also be maintained for other incidents (property damage, fire or explosion, spill, release, potential violation, and near misses) as part of our loss prevention and risk reduction initiative.

22.5 Serious Incident Reporting Requirements

(Reference CH2M HILL SOP HSE-111, *Incident Reporting, Notification and Investigation*)

The Serious Incident Reporting Requirements ensures timely notification and allows for positive control over flow of information so that the incident is handled effectively, efficiently, and in conjunction with appropriate corporate entities. This standard notification process integrates Health, Safety, Security and Environment (HSSE) and Firm Wide Security Operations (FWSO) requirements for the consistent reporting of and managing of serious events throughout our operations.

22.5.1 Serious Incident Determination

The following are general criteria for determining whether an incident on CH2M HILL owned or managed facilities or program sites is considered serious and must be immediately reported up to Group President level through the reporting/notification process:

- Work related death, or life threatening injury or illness of a CH2M HILL employee, subcontractor, or member of the public
- Kidnap/missing person
- Acts or threats of terrorism
- Event that involves a fire, explosion, or property damage that requires a site evacuation or is estimated to result in greater than $ 500,000 in damage.
- Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment.

22.5.2 Serious Incident Reporting

If an incident meets the "Serious Incident" criteria, the Project Manager is to immediately contact the Crisis Manager at 720-286-4911, then follow the standard incident reporting procedure.

For all serious incidents this standard reporting process is implemented immediately so as to ultimately achieve notification to the Business Group President within 2 hours of incident onset or discovery, and notification to appropriate corporate Crisis Management Support Team.

ESBG US Operations
Incident Reporting Flow Diagram

Direct Reporting Responsibility

Informational Reporting

Incident:
- Injury or illness
- Hazardous substance exposure
- Damage to property
- Fire or explosion
- Spill, release, potential violation, or permit exceedance
- A "near-miss"

If incident is an **injury** to US or Puerto Rico based CH2M HILL personnel contact the Occupational Health Nurse at 866/893-2514. Outside the US, the supervisor must notify HR

The Ops Leader is responsible for completing the Incident Report Form (IRF) in **HITS** when there is an injury to a CH2M HILL employee. The PM, CM or SC is responsible for completing the IRF for all other incidents. ***The IRF/HITS must be completed within 24 hours of the incident and does not replace the required immediate PM and RHSM notifications.***

Incident
Ensure that Emergency Responders have been notified as necessary

Employee or Subcontractor
Provide immediate notification.

Supervisor – Construction Manager - Safety Coordinator
Provide immediate notification by phone and email to PM and RHSM. In addition, for spills, NOVs, and permit issues you may also call the EM.

CRISIS MANAGER:
If the incident meets the "**Serious Incident**" criteria, contact the Crisis Manager

(720.286.4911)

Third Party – Incidents outside of our contractual obligations do not need to be communicated, unless they are serious and/or may affect CH2M HILL. The RHSM will determine the level of communication necessary for third party incidents.

Serious Incident:
- Work related death, or life threatening injury or illness of a CH2M HILL employee, subcontractor, or member of the public
- Kidnap/missing person
- Acts or threats of terrorism
- Event that involves a fire, explosion, or property damage that requires a site evacuation or is estimated to result in greater than $ 500,000 US in damage.
- Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment.

Responsible HSM (RHSM)
Immediately notify the Sector OR Client Program HSE Manager, immediately notify the Responsible Environmental Manager (EM) for spills, NOVs, and permit issues, and direct the incident investigation.

Client Program HSE Manager
Notify Sector HSM, and coordinate communication and incident investigations.

Immediate notification to the Sector HSM is not required for some minor incidents. Follow the program or sector protocol.

Sector HSE Manager
Coordinate communication, direct significant incident investigations, notify Sector EM for spills, NOVs, & permit issues.

HSSE Director
Provide decision-making assistance or direction for incident resolution.

Project Manager
Provide notification to the Sector OR Program Project Delivery (PD) or Operations (Ops) Manager or designee. Notification is based on program or sector specific criteria. Immediate notification to the PD/Ops Manager is not required for some minor incidents. Follow the program or sector protocol.

Sector or Program PD/Ops Manager
Notify Client Program Manager OR Sector Director, provide guidance and follow the incident through to resolution.

Client Program Manager
Notify Sector Director; provide decision-making assistance or direction for incident resolution.

Keep unnecessary communication of serious incidents to a minimum.

Sector Director
Provide decision-making assistance or direction for incident resolution.

ES US Operations Director/ Executive Leadership Team
Provide decision-making assistance, direction for incident resolution, and make higher level notifications as necessary

Post-emergency incident communications regarding serious incidents at a CH2M HILL office or project (regardless of the party involved) shall be considered sensitive in nature and must be controlled in a confidential manner.

22.6 Incident Root Cause Analysis

The accident analysis is essential if all causes of the incident are to be identified for the correct remedial actions to be taken to prevent the same and similar type of incident from recurring. The investigation team will consist of the SC (with support from RHSM), appropriate subcontractor personnel as necessary, the PM, and the responsible supervisor. More participants may be involved as needed to complete the investigation.

The Root Cause Analysis Form must be completed for all Loss Incidents and Near Loss Incidents. This form must be submitted to the investigation team for review.

For minor losses or near losses, the information may be gathered by the supervisor or other personnel immediately following the loss. Based on the complexity of the situation, this information may be all that is necessary to enable the investigation team to analyze the loss, determine the root cause, and develop recommendations. More complex situations may require the investigation team to revisit the loss site or re-interview key witnesses to obtain answers to questions that may arise during the investigation process.

Photographs or videotapes of the scene and damaged equipment should be taken from all sides and from various distances. This point is especially important when the investigation team will not be able to review the loss scene.

The investigation team must use the Root Cause Analysis Flow Chart to assist in identifying the root cause(s) of a loss. Any loss may have one or more root causes and contributing factors. The root cause is the primary or immediate cause of the incident, while a contributing factor is a condition or event that contributes to the incident happening, but is not the primary cause of the incident. Root causes and contributing factors that relate to the person involved in the loss, his or her peers, or the supervisor should be referred to as “personal factors.” Causes that pertain to the system within which the loss or injury occurred should be referred to as “job factors.”

22.6.1 Personal Factors

- Lack of skill or knowledge
- Correct way takes more time and/or requires more effort
- Short-cutting standard procedures is positively reinforced or tolerated
- Person thinks there is no personal benefit to always doing the job according to standards

22.6.2 Job Factors

- Lack of or inadequate operational procedures or work standards
- Inadequate communication of expectations regarding procedures or standards
- Inadequate tools or equipment

The root cause(s) could be any one or a combination of these seven possibilities or some other uncontrollable factor. In the vast majority of losses, the root cause is very much related to one or more of these seven factors. Uncontrollable factors should be used rarely and only after a thorough review eliminates all seven other factors.

22.6.3 Corrective Actions

Include all corrective actions taken or those that should be taken to prevent recurrence of the incident. Include the specific actions to be taken, the employer and personnel responsible for implementing the actions, and a timeframe for completion. Be sure the corrective actions address the causes.

Once the investigation report has been completed, the PM shall hold a review meeting to discuss the incident and provide recommendations. The responsible supervisors shall be assigned to carry out the recommendations, and shall inform the SC upon successful implementation of all recommended actions.

- The RHSM will inform the Responsible Environmental Manager (REM) of any environmental incidents.
- Evaluation and follow-up of the IRF will be completed by the type of incident by the RHSM, REM, or FWSO. The Business Group (BG) HSE Lead will review all BG incidents and modify as required.
- Incident Investigations must be initiated and completed as soon as possible but no later than 72 hours after the incident.

SECTION 23

Records and Reports

An organized project filing system is essential for good documentation and recordkeeping. There are many benefits to an organized filing system:

- Other CH2M HILL employees can easily and quickly find documents
- Records are readily available for review
- Records may be needed during OSHA investigations, audits, or other legal matters
- Records may be needed on short notice in case of an accident, illness or other emergency
- Systematic recordkeeping aids in overall project organization

The project filing system shall be established at the beginning of the project and maintained throughout all phases of construction and archived in accordance with CH2M HILL's Records Retention Policy. The information contained in the filing system shall be updated regularly and/or as specified in this document. The PM and SC are responsible for collecting documentation, including subcontractor documentation, and maintaining a complete and organized filing system.

Below are examples of records that must be maintained as the project progresses:

- Exposure records includes air monitoring data (including calibration records), MSDSs, exposure modeling results.
- Physical hazard exposure records include noise, ionizing radiation, non-ionizing radiation, vibration, and lasers exposure assessments and measurements.
- Respiratory Fit Test Records
- Training Records
- Injury/illness reports and investigations
- Federal or State Agency Inspection Records
- Other Records
  - Ergonomic evaluations
  - HSE audits and assessments
  - Project-Specific HSE Plans
  - Confined Space Entry Permits
  - Equipment inspections
  - Equipment maintenance
  - SBOs
  - Self-Assessment Checklists

Health and Safety Plan Employee Sign-off Form

EMPLOYEE SIGNOFF FORM

Health and Safety Plan

The CH2M HILL project employees and subcontractors listed below have been provided with a copy of this HSP, have read and understood it, and agree to abide by its provisions.

Project Name: **Project Number:**

EMPLOYEE NAME (Please print)	EMPLOYEE SIGNATURE	COMPANY	DATE

Chemical Inventory/Register Form

CH2MHILL

CHEMICAL INVENTORY/REGISTER FORM

Refer to SOP HSE-107, Attachment 1, for instructions on completing this form.

Location:

HCC:

☐ Office ☐ Warehouse ☐ Laboratory ☐ Project:

Project No.:

Regulated Product	Location	Container labeled (✓if yes)	MSDS available (✓if yes)

MSDS for the listed products will be maintained at:

Chemical-Specific Training Form

CH2MHILL

CHEMICAL-SPECIFIC TRAINING FORM

Refer to SOP HSE-107 Attachment 1 for instructions on completing this form.

Location:	Project #:
HCC:	Trainer:

TRAINING PARTICIPANTS:

NAME	SIGNATURE	NAME	SIGNATURE

REGULATED PRODUCTS/TASKS COVERED BY THIS TRAINING:

The HCC shall use the product MSDS to provide the following information concerning each of the products listed above.

☐ Physical and health hazards

☐ Control measures that can be used to provide protection (including appropriate work practices, emergency procedures, and personal protective equipment to be used)

☐ Methods and observations used to detect the presence or release of the regulated product in the workplace (including periodic monitoring, continuous monitoring devices, visual appearance or odor of regulated product when being released, etc.)

Training participants shall have the opportunity to ask questions concerning these products and, upon completion of this training, will understand the product hazards and appropriate control measures available for their protection.

Copies of MSDSs, chemical inventories, and CH2M HILL's written hazard communication program shall be made available for employee review in the facility/project hazard communication file.

CH2M HILL Health and Safety Plan

Attachment 4

Project Activity Self-Assessment Checklists (available on VO)/Permits/Forms

Drilling
Electrical
Hand and Power Tools
PPE
Traffic Control

CH2M HILL Health and Safety Plan

Attachment 5

Behavior Based Loss Prevention System Forms

Activity Hazard Analysis

Pre-Task Safety Plans

Safe Behavior Observation

Incident Report and Investigation

(use electronic form when possible)

HITS

ACTIVITY HAZARD ANALYSIS FORM

Activity:	**Surveying Services**	**Date:**	August 8, 2011
		Project:	Naval Weapons Station CTO-WE29
Description of the Services:	**Surveying Services – Monitoring Well Locations**	**Site Supervisor:**	Wade A Rhodes (40 Hour HAZWOPER trained)
		Site Safety Officer:	Wade A Rhodes (40 Hour HAZWOPER trained)

Task Breakdown	Potential Hazards	Critical Safety Practices	RAC	Personal Protective Clothing and Equipment
Field Surveying	Operating motor Vehicle	-Inspect vehicle before use. -Wear seat belts at all times -Observe posted speeds. -Utilize headlights at all times when vehicle is in motion. -Always check behind vehicle when backing up -Assure load is secured and anchored so that it cannot shift -Keep doors of vehicles closed at all times while in travel -Do not park on a dry grassed surface	L	Standard Level D PPE * Level D* Work clothes, reflective vests/ high visibility clothing, hard hat (when overhead hazards are present) safety glasses and sturdy hard toed work boots that provide sufficient ankle support, hand, hearing and face protection, as dictated by task.
	Exposure to Wind, Temperature Extremes and Precipitation	-Obtain and Weather Forecast – be prepared for sudden changes in weather Be aware of the symptoms of heat and cold-related disorders, and wear proper, layered clothing for the anticipated fieldwork: - Wear clothing that will effectively block the wind. - During warm weather or excessive heat, wear clothes that breath, especially cotton work cloths - Ensure that gloves, hard hat liners, are available and worn if required. - Ensure that crew has proper boots for the anticipated weather conditions extreme temperature conditions. -Ensure that crew members have dry boots to wear for each shift. - Provide rain gear or other impermeable clothing during periods of precipitation. Monitor employees for signs of heat and cold stress, heat stress could occur during the period of conduct of this project. If stresses are present employee is to stop work immediately, hydrate & seek medical attention if warranted. Adjust the work schedule to ensure that employees do not suffer heat and./or cold related illnesses	L	Standard Level D PPE *
	Weather Hazards	-Obtain and Weather Forecast – be prepared for sudden changes in weather if Lighting is in close proximity to work site work will be suspended until weather passes. Practice 30/30 rule, Seek refuge when thunder sounds within 30 seconds after a lightning flash; and do not resume activity until 30 minutes after the last thunder clap if a persistent rain is encountered, work will be suspended until weather passes If the crew chief determines wind is excessive and is a safety concern, work will be suspended	L	Standard Level D PPE *
	Fire Prevention	• Only smoke in designated areas. Designated area must be free of combustible/flammable materials.	M	Standard Level D PPE *

Task Breakdown	Potential Hazards	Critical Safety Practices	RAC	Personal Protective Clothing and Equipment
Land Surveys (cont.)	High Ambient Temperature	• Provide and drink fluids to prevent worker dehydration. • Minimize intake of caffeinated fluids. • Institute a proper work-break regiment in a cool area to avoid heat stress symptoms and overexertion. • Monitor for signs and symptoms of heat stress (maintain use of buddy system) when the ambient air temperature exceeds 70°F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress and especially when wearing disposable or other types of coveralls. 1) Heat Syncope = Sluggishness or fainting while standing erect or immobile in heat. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete*. 2) Heat Rash = Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure. *Treatment = Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.* 3) Heat Cramps = Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake.* 4) Heat exhaustion = Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid thready pulse and low blood pressure; oral temperature normal or low. *Treatment = Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.* 5) Heat Stroke = Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature. *Treatment = Cool rapidly by soaking in cool–but not cold–water. Call ambulance, and get medical attention immediately!*	L	Standard Level D PPE * (light colored clothing)
	Tool Use Hazards	-Tools shall be inspected prior to use and damaged tools will be tagged and removed from service. -All tools will be used for their intended use only and operated in accordance with industry standards. --Only personnel trained in the proper use and maintenance of the a specific tool is to use that tool -All power tools equipped with a safety guard of any type shall be used only with the guard in place and functioning properly. -Portable power tools will be connected into GFCI protected outlets. Portable power tools will be underwriters Laboratories (UL) listed and have a three-wire grounded plug or be double insulated. -Electric tools shall be disconnected when changing attachments or performing maintenance.	L	
	Slips, Trips and Falls	-Walking and working surfaces will be kept free of clutter, debris and congestion. Be aware of wet and slippery conditions. -Identify footing hazards prior to and during access to rough areas and steep terrain. -Ensure work areas are kept free of clutter and areas are adequately lit during night operations.	L	

Task Breakdown	Potential Hazards	Critical Safety Practices	RAC	Personal Protective Clothing and Equipment
	Plant Hazards	-Be aware of the appearance of poisonous plants. (e.g. Poison Ivey, Poison Oak, etc.) -Be aware of the presence of thorns, briars and other plants with sharp edges or points -Wear long pants and long sleeves. - Tyvek coveralls, gloves, and boot covers must be worn when entering areas of poisonous plants. Implement additional control measures as specified in CH2M HILL HSP	L	
	Small Animal and insect Hazards	-Do not feed or otherwise encourage native species to be friendly or approach. -If scratched or bitten, immediately seek medical attention. Spray clothing with repellant. Tape trouser bottoms and wear bug out suits if appropriate. Wasps may inhabit well cases. Open well case carefully. Watch for spiders in residence in well cases. -if ticks are present, apply insect repellant, tape pant cuffs, tuck in shirts. Once work is complete inspect Clothing/body for ticks and remove. If bitten by a tick. Monitor bite site for allergic reaction.	L	
	Lifting Hazards	-Minimize lifting or carrying distances by preplanning storage and staging. -Split heavy loads into smaller loads if possible. -Use mechanical lifting aids and equipment whenever possible. -Have someone assist with the lift – especially for heavy or awkward loads. -Assure that the path of travel is clear prior to the lift. -Assure installed equipment is stable when in use USE PROPER LIFTING - Get as close to the load as possible. Avoid picking up heavy objects placed below your knees. Keep your back straight when reaching to lift an object. Tighten your stomach muscles to keep your spine from twisting while lifting a load. Bend with your knees not your back. Stretch and loosen up before work. Change direction by moving your feet not your hips. Look ahead to make sure the path is clear. Never twist at the waist while carrying a load. Set the load down if it becomes unstable or too heavy. Remember to “push” not “pull” whenever possible.	L	
	Visible Lighting	• Perform tasks in daylight hours whenever possible. If dawn, dusk or dark work is to be performed portable lightly must be provided to sufficient illuminate work area(s).	L	Standard Level D PPE *
	Vehicular Traffic	• Shut off and secure site vehicles prior to exiting them. Park on level ground where possible. If parking on an incline, engage parking brake. If the vehicle has a manual transmission, ensure the transmission is in gear (not neutral) and the parking brake is engaged before exiting the vehicle. • Exercise caution when exiting traveled way or parking along street— avoid sudden stops, use flashers, etc. • Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier. • All staff working adjacent to traveled way or within work area must wear reflective/high-visibility safety vests.	L	Standard Level D PPE *

Task Breakdown	Potential Hazards	Critical Safety Practices	RAC	Personal Protective Clothing and Equipment
Trimble GPS and Robotic Surveying Equipment	Set up procedures	-Inspect all equipment prior to use -Calibrate equipment as needed -All Field Crew personnel have been trained to use equipment. -Use proper carrying techniques to carry equipment long distances	L	Level D_1 or D_2 Modified PPE *
	Driving Stakes, Hubs or Iron Rods	-Tools shall be inspected prior to use and damaged tools will be tagged and removed from service. - When Driving Stakes, Hubs or Iron Rods, hands will be kept out of the line of driving tools, MSM personnel will wear safety glasses to protect from flying debris when driving these items.		
	Other	• **Verify that EMS services are available and can respond in a prompt manner prior to the start of work.** • Personnel using survey equipment containing lasers shall be trained to utilize that equipment properly. Personnel operating laser equipped survey equipment must avoid exposing their eyes to direct or indirect laser light energy sources. • Always using a seat belt while driving on military/government facilities. Always observe posted speed limits, traffic signs and signals. Never using a cell phone or two way radio while driving on military/government facilities. Violating these rules may result in loss of military/government facility driving privileges. • Buddy System maintained for all phases of work. • Base or Local Emergency medical Service and Fire Dispatch numbers programmed into cellular phones. Have hospital route maps readily available. • Report all unsafe conditions and acts, injury/illness or property damage to supervisors immediately.	L	Standard Level D PPE *

EQUIPMENT REQUIRED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Eye wash (small portable type) • First Aid/BbPK/CPR shield • Communication devices • Land Survey Equipment	• Visual Inspections of designated work areas identify and address hazardous conditions. • Emergency Response equipment Inspections (Fire Extinguishers, Eye wash First Aid/CPR etc.)	• Review AHA with all task personnel • Review Site Specific Health and Safety Plan for new site personnel. • Supervisors - 1st Aid/CPR (two people on-site) and 10 hour OSHA Construction training (or equivalent) or Hazardous Waste Trained • Competent Person Requirement & Name: NA

DATE PREPARED: 8/8/11

DATE REVISED: N/A

PREPARED BY/REVISED BY): Paul W. Michaels Jr.
REVIEWED BY (Name/Title): Wade A. Rhodes and Carl Woods – CH2M HILL Health and Safety Manager

NOTES (Field Notes, Review Comments, etc.):

Overall Risk code: Low Risk

Overall Risk Assessment Code (RAC) (Use highest code)					
Risk Assessment Code (RAC) Matrix					
Severity	**Probability**				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

	RAC Chart
"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.	E = Extremely High Risk
"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible	H = High Risk
Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.	M = Moderate Risk L = Low Risk

Activity:	**Utility Designation of Subsurface Utilities**	**Date:**	September 23, 2011
		Project:	Naval Weapons Station CTO-WE29
Description of the Services:	**Identify and mark all subsurface utilities that lie within a radius of 10feet of each of 4 drilling locations at Site 32.**	**Site Supervisor:**	
		Site Safety Officer:	

ACTIVITY HAZARD ANALYSIS – Utility Clearance

Task Breakdown	Potential Hazards	Critical Safety Practices	RAC	Personal Protective Clothing and Equipment
Utility Clearance	Adverse Weather	• Check internet, local TV weather or radio channels for daily forecasts and plan daily work activities accordingly. Have a portable radio available on-site to monitoring local weather or marine forecasts. If on-site internet or radio monitoring are not available, check with home office support personnel who may be able to verify pending regional severe weather conditions. • Frequently observe the skyline for developing rain squalls and thunder storms systems that may develop. • Bring clothing suitable for anticipated daily weather conditions. • Shut down operations during heavy rain/lightning events or high wind conditions. For storms producing lightning, seek safe haven in a grounded structure or rubber vehicle. Implement 30 – 30 rule. Do not seek refuge under trees during electrical or high wind storm events. • Stay away from ravines and gullies during heavy rain events, because of the possibility of flash flood events. • Do not use telephones during electrical storms, except in the case of emergency.	L	Standard Level D PPE * Level D * Work clothes, reflective vests/ high visibility clothing, hard hat, safety glasses and sturdy hard toed work boots that provide sufficient ankle support, hand, hearing and face protection, as dictated by task.
	Manual Lifting	• CH2MHILL or subcontract personnel must notify supervisors or safety representatives of preexisting medical conditions that may be aggravated or re-injured by lifting activities, especially lifting operation involving repetitive motions. • Perform a muscle warming/stretching regiment prior to performing any manual lifting operations. • When lifting objects, lift using knees not back. For repetitive lifting tasks, the use of lifting braces/supports may be considered. Use heavy equipment to transfer heavy or awkward loads wherever possible. Have someone assist with the lift— especially for heavy (> 40lbs.) or awkward loads. Do not attempt to manually lift objects that should otherwise be lifted with heavy equipment. • Plan storage and staging to minimize lifting or carrying distances. Make sure the path of travel is clear prior to the lift. • Avoid carrying heavy objects above shoulder level.	L	Standard Level D PPE *

ACTIVITY HAZARD ANALYSIS – Utility Clearance				
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**RAC**	**Personal Protective Clothing and Equipment**
Utility Clearance (cont.)	Slips, Trips, Falls	• Be aware of poor footing, potential slipping/tripping hazards in the work area, such as wet/steep slopes, stumps/roots, unprotected holes, ditches, rip rap, utilities, ground protrusions (well casings). Observe and avoid areas of unprotected holes, ramps and ground penetrations or protrusions (stumps, roots, holes curbs, utility structures etc). Use sturdy hard toe work boots with sufficient ankle support. • Institute and maintain good housekeeping practices. Clean Work Areas as activities proceed. Clear/removed materials and debris from pathways and commonly traveled areas as soon as possible.	L	Standard Level D PPE *
	Fire Prevention	• Only smoke in designated areas. Designated area must be free of combustible/flammable materials.	M	Standard Level D PPE *
	High Ambient Temperature	• Provide and drink fluids to prevent worker dehydration. • Minimize intake of caffeinated fluids. • Institute a proper work-break regiment in a cool area to avoid heat stress symptoms and overexertion. • Monitor for signs and symptoms of heat stress (maintain use of buddy system) when the ambient air temperature exceeds 70°F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress and especially when wearing disposable or other types of coveralls. 1) Heat Syncope = Sluggishness or fainting while standing erect or immobile in heat. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete*. 2) Heat Rash = Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure. *Treatment = Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.* 3) Heat Cramps = Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake.* 4) Heat exhaustion = Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid thready pulse and low blood pressure; oral temperature normal or low. *Treatment = Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.* 5) Heat Stroke = Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature. *Treatment = Cool rapidly by soaking in cool–but not cold–water. Call ambulance, and get medical attention immediately!*	L	Standard Level D PPE * (light colored clothing)

ACTIVITY HAZARD ANALYSIS – Utility Clearance				
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**RAC**	**Personal Protective Clothing and Equipment**
Utility Clearance (cont.)	Visible Lighting	• Perform tasks in daylight hours whenever possible. If dawn, dusk or dark work is to be performed portable lightly must be provided to sufficient illuminate work area(s).	L	Standard Level D PPE *
	Vehicular Traffic	• Shut off and secure site vehicles prior to exiting them. Park on level ground where possible. If parking on an incline, engage parking brake. If the vehicle has a manual transmission, ensure the transmission is in gear (not neutral) and the parking brake is engaged before exiting the vehicle. • Exercise caution when exiting traveled way or parking along street— avoid sudden stops, use flashers, etc. • Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier. • All staff working adjacent to traveled way or within work area must wear reflective/high-visibility safety vests.	L	Standard Level D PPE *
	Biological	• Observe ground surfaces, enclosed structures, ground water well heads, surrounding vegetation other site features for presence of spiders, bee/wasp hives, other stinging insects etc. • **Prior to starting field activities, notify supervisors of known allergies to stinging insects and location of antidotes.** • Use insect repellant with DEET or other insect repellent to deter being bit by mosquitoes or other stinging/biting insects. • Tape pant legs to boots and ensure there are no open seams between boots and pant legs where there is a potential for exposure to fire ants. • Avoid exposure to blood borne pathogens. Use universal precautions against exposure when administering first aid.	L	Level D_1 or D_2 Modified PPE *
	Other	• **Verify that EMS services are available and can respond in a prompt manner prior to the start of work.** • Personnel using survey equipment containing lasers shall be trained to utilize that equipment properly. Personnel operating laser equipped survey equipment must avoid exposing their eyes to direct or indirect laser light energy sources. • Always using a seat belt while driving on military/government facilities. Always observe posted speed limits, traffic signs and signals. Never using a cell phone or two way radio while driving on military/government facilities. Violating these rules may result in loss of military/government facility driving privileges. • Buddy System maintained for all phases of work. • Base or Local Emergency medical Service and Fire Dispatch numbers programmed into cellular phones. Have hospital route maps readily available. • Report all unsafe conditions and acts, injury/illness or property damage to supervisors immediately.	L	Standard Level D PPE *

EQUIPMENT REQUIRED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Eye wash (small portable type) • First Aid/BbPK/CPR shield • Communication devices • ER/GPR/Magnetometer scanning equipment	• Visual Inspections of designated work areas identify and address hazardous conditions. • Emergency Response equipment Inspections (Fire Extinguishers, Eye wash First Aid/CPR etc.)	• Review AHA with all task personnel • Review Site Specific Health and Safety Plan for new site personnel. • Supervisors - 1st Aid/CPR (two people on-site) and 10 hour OSHA Construction training (or equivalent) & Hazwoper Trained • Competent Person Requirement & Name: NA

DATE PREPARED: 9/23/2011

DATE REVISED: N/A

PREPARED BY/REVISED BY): Valerie Mayhew
REVIEWED BY (Name/Title): Carl Woods – CH2M HILL Health and Safety Manager

NOTES (Field Notes, Review Comments, etc.):

Overall Risk code: Low Risk

Overall Risk Assessment Code (RAC) (Use highest code)					
Risk Assessment Code (RAC) Matrix					
Severity	**Probability**				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.	RAC Chart
"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible	E = Extremely High Risk H = High Risk
Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.	M = Moderate Risk L = Low Risk

	PRINT	SIGNATURE	
Supervisor Name:	______________________________	______________________________________	**Date/Time:**______________
Safety Officer Name:	______________________________	______________________________________	**Date/Time:**______________
Site Personnel:	______________________________	______________________________________	**Date/Time:**______________
	______________________________	______________________________________	**Date/Time:**______________
	______________________________	______________________________________	**Date/Time:**______________
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	______________________________	______________________________________	**Date/Time:**______________
	______________________________	______________________________________	**Date/Time:**______________
	______________________________	______________________________________	**Date/Time:**______________

Activity:	**Drilling Services**	**Date:**	September 20, 2011
		Project:	Naval Weapons Station CTO-WE29
Description of the Services:	**Drilling & Monitoring Well Installation**	**Site Supervisor:**	Butch Stephens
		Site Safety Officer:	Butch Stephens (40 Hour HAZWOPER Trained)

ACTIVITY HAZARD ANALYSIS – Drilling

Task Breakdown	Potential Hazards	Critical Safety Practices	RAC	Personal Protective Clothing and Equipment
Drilling/Groundwater Well Installation/ Well Development	Adverse Weather	• Check internet, local TV weather or radio channels for daily forecasts and plan daily work activities accordingly. Have a portable radio available on-site to monitoring local weather or marine forecasts. If on-site internet or radio monitoring are not available, check with home office support personnel to assist with checking internet sources and identifying any severe weather developments that may be projected in the region of the project site. • Frequently observe the skyline for developing rain squalls and thunder storms systems that may develop. • Bring clothing suitable for anticipated daily weather conditions. • Shut down operations during heavy rain/lightning events or high wind conditions. For storms producing lightning, seek safe haven in a grounded structure or rubber vehicle. Implement 30 – 30 rule. Do not seek refuge under trees during electrical or high wind storm events. • Stay away from ravines and gullies during heavy rain events, because of the possibility of flash flood events. • Do not use telephones during electrical storms, except in the case of emergency.	L	Level D_1 or D_2 Modified PPE * D: Work clothes, reflective vests, hard hat, safety glasses and sturdy hard toed work boots, hearing and hand protection as necessary for task. D_1 : D + hand protection (inner and outer chemical resistant gloves) D_2: D_1+ chemical resistant suits and boot covers, face protection (as needed)
	Biological	• Observe ground surfaces, enclosed structures, ground water well heads, surrounding vegetation other site features for presence of spiders, bee/wasp hives, other stinging insects etc. • **Prior to starting field activities, notify supervisors of known allergies to stinging insects and location of antidotes.** • Use insect repellant with DEET or other insect repellent to deter being bit by mosquitoes or other stinging/biting insects. • Tape pant legs to boots and ensure there are no open seams between boots and pant legs where there is a potential for exposure to fire ants. • Avoid exposure to blood borne pathogens. Use universal precautions against exposure when administering first aid.	L	Level D_1 or D_2 Modified PPE *
	Concrete/Grout Mixing	• When mixing concrete/grout for the installation groundwater (GW) wells concrete pads, grouting GW well annulus, do not breathe cement dust or get concrete dust or mixed concrete on your skin or in your eyes. • When emptying concrete/cement bags for hand mixing of concrete, have an assistant mist cement powder to minimize airborne cement dust. • Wear dust mask when visible dust emission occur in personal breathing zone.	M	Level D_1 or D_2 Modified PPE *
	Cuts & Abrasions	• Wear cut resistant work gloves, when the possibility of lacerations or other injury may be caused by sharp edges of hand tools or drilling equipment tools. • Do not use razor knives.	M	Level D_1 or D_2 Modified PPE *

ACTIVITY HAZARD ANALYSIS – Drilling				
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**RAC**	**Personal Protective Clothing and Equipment**
Groundwater Well Installation/Soil Sampling and Well Development (Cont.)	Buried Utilities or Unknown Objects	• Contact **State One Call** to secure a utility owner verification request number for utility clearance verification. Keep copies of any written documentation (faxes, email printouts) regarding utility location verification provided by utilities owners in the office project file and in a working field file on-sit • Review base engineering records or drawings against utility owner or third party utility mark-out to verify any potential differences. • Photo document owner provided field utility mark-outs as related to proposed limits of ground disturbing activities prior to the start of work. • Conduct "third" party utility clearance when the locations of utilities may be in question and document results of third party utility location. • Hand dig around identified utilities (within 5') or as otherwise required by NWSY • Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, utilities must be relocated/marked. • Where unknown or unanticipated buried objects are encountered (i.e. drums, tanks, cylinders, munitions of explosive concern, soil with unusual staining or odor) CH2MHILL or subcontractor personnel shall 1) secure equipment to the extent possible, without causing bodily injury, 2) evacuate the work area and 3) immediately notify the site manager, SSHO or PM of the encountered condition. Work may only resume with appropriate documentation/notification that exposure hazards (physical or chemical) do not exist. Notify CH2MHILL PM and program officials and applicable NAVFAC POCs and do not resume work until authorized to do so.	M	Level D_1 or D_2 Modified PPE *
	Chemical Exposure	• Where contact with free phase petroleum product is POTENTIALLY NOT LIMITED to hands then Modified Level D (D_2) PPE with disposable coveralls is required. • All personnel performing this task shall be trained in accordance with 29CFR1910.120 and be rolled in a medical monitoring program. • Pregnant or potentially pregnant personnel to review Standard of Practice HSE-120, Reproductive Protection before performing any hazardous or potentially hazardous duty. • Do not allow dermal contact or incidental ingestion of impacted soil or groundwater. Skin contact with contaminated water, soils, debris, or equipment shall be avoided at all times. Do not kneel or step in potentially contaminated media (soil or ground water) without first donning proper PPE. • Exercise good hygiene practices. Always wash hands before eating, drinking, smoking and leaving site. Only eat, drink, smoke or chew tobacco in designated areas. • Do not allow on-site haul truck operators to climb into dump bodies without proper PPE. • Adhere to PPE and action monitoring level requirements identified in HSP • When mixing concrete for the installation of concrete pads or bollard footings, don not breath cement dust or get concrete dust or mixed concrete on your skin or in your eyes.	L	Level D_1 or D_2 Modified PPE *

ACTIVITY HAZARD ANALYSIS – Drilling				
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**RAC**	**Personal Protective Clothing and Equipment**
Groundwater Well Installation/Soil Sampling and Well Development (Cont.)	Drilling Equipment	• Drillers must verify that the rig is properly leveled and stabilized. • Driller must check for overhead power lines before raising mast. A minimum distance of 10ft between mast and overhead lines. • Personnel should be cleared from sides and rear of rig while mast is raised. Driller will not drive while mast is in the raised position. • Do not wear loose fitting clothing or watches that may get caught in moving parts • Kill wire or switch must be able to located and activated by all personnel supporting the operation. • Drill rig should be equipped with a fire extinguisher. • The driller is to verify that the drill rig and cabling is maintained, in proper working condition and inspected before operation. Keep documentation on site. • Avoid/take care around pressurized lines/hoses. Inspect hoses daily for cuts, abrasions and wear. • Equipment shall only be operated by personnel qualified by prior training or experience. • Do not smoke or use other spark-producing equipment near rig. • For pneumatically pressured lines, safety lashes or whip checks should be affixed to hoses to prevent injury in the event of rupture. • Drillers are to verify that all machine guards are in place while in operation.	H	Level D_1 or D_2 Modified PPE *
	Electrical Safety	• Do not connect car batteries direct to sampling devices for power. Use a generator, GCFI or other protected circuit. • If/when electrical extension cords are required to complete work, extension cords must be: - Equipped with third-wire grounding. - Covered, elevated, or protected from damage when passing through work areas. - Protected from pinching if routed through doorways. - Not fastened with staples, hung from nails, or suspended with wire. - Extension cords and electrical power tools, must have ground fault circuit interrupters (GFCIs) installed. - Inspected all extension cords daily for structural integrity, ground continuity, and damaged insulation. - Kept out of water/liquids. - Electrical power circuits should be inspected before plugging in extension cords. - Maintain proper separation between Power Transmission Lines/over overhead utilities and drill rig masts. See Electric Safety section in HSP for references to proper separation between operating equipment and power transmission lines/overhead utilities.	M	Level D_1 or D_2 Modified PPE *

ACTIVITY HAZARD ANALYSIS – Drilling				
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**RAC**	**Personal Protective Clothing and Equipment**
Groundwater Well Installation/Soil Sampling and Well Development (Cont.)	Fire Prevention	• Only smoke in designated areas. Designated area must be free of combustible/flammable materials. • Use only metal safety cans for storage and transfer of fuel. • Use funnels and nozzles during fueling operations. • Appropriately sized, easily accessible ABC fire extinguisher in work area. Fire extinguishers must be inspected monthly (inspection tag) and have an annual maintenance/inspection certification (tag) attached to the extinguisher. • Fire extinguishers shall be approved by a nationally recognized testing laboratory and labeled to identify the listing and labeling organization and the fire test and performance standard that the fire extinguisher meets or exceeds.	M	Level D_1 or D_2 Modified PPE *
	Hand Tools	• Select and use the proper tool for the task. • Do not use tools that have been damaged or repaired in a manner which is not consistent with manufacturer's requirements. • Ensure that pipe wrenches have a secure grip on drill rods and sample devices that are being disassembled. • While using pipe wrenches, ensure that other workers are not in close proximity to a wrench being used in the event the wrench grip is lost	L	Level D_1 or D_2 Modified PPE *
	Heavy Equipment	• Perform daily maintenance on operating equipment. • Equipment (Drill Rig) shall only be operated by personnel qualified by prior training or experience. • Ensure that a stable ground surface is available for the operation of heavy equipment (drill rig).	M	Level D_1 or D_2 Modified PPE *

ACTIVITY HAZARD ANALYSIS – Drilling				
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**RAC**	**Personal Protective Clothing and Equipment**
Groundwater Well Installation/Soil Sampling and Well Development (Cont.)	High Ambient Temperature	• Provide and drink fluids to prevent worker dehydration. • Minimize intake of caffeinated fluids. • Institute a proper work-break regiment in a cool area to avoid heat stress symptoms and overexertion. • Monitor for signs and symptoms of heat stress (maintain use of buddy system) when the ambient air temperature exceeds 70°F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress and especially when wearing disposable or other types of coveralls. 1) Heat Syncope = Sluggishness or fainting while standing erect or immobile in heat. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete*. 2) Heat Rash = Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure. *Treatment = Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.* 3) Heat Cramps = Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake.* 4) Heat exhaustion = Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid thready pulse and low blood pressure; oral temperature normal or low. *Treatment = Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.* 5) Heat Stroke = Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature. *Treatment = Cool rapidly by soaking in cool–but not cold–water. Call ambulance, and get medical attention immediately!*	H	Level D_1 or D_2 Modified PPE * (light weight cotton/breathable clothing underneath)
	Manual Lifting	• CH2MHILL or subcontract personnel must notify supervisors or safety representatives of preexisting medical conditions that may be aggravated or re-injured by lifting activities, especially lifting operation involving repetitive motions. • Perform a muscle warming/stretching regiment prior to performing any manual lifting operations. • When lifting objects, lift using knees not back. For repetitive lifting tasks, the use of lifting braces/supports may be considered. Use heavy equipment to transfer heavy or awkward loads wherever possible. Have someone assist with the lift— especially for heavy (> 40lbs.) or awkward loads. Do not attempt to manually lift objects that should otherwise be lifted with heavy equipment. • Plan storage and staging to minimize lifting or carrying distances. Make sure the path of travel is clear prior to the lift. • Avoid carrying heavy objects above shoulder level.	L	Level D_1 or D_2 Modified PPE *
	Noise	• Personnel exposed to loud working environments shall wear hearing protection.	L	Level D_1 or D_2 Modified PPE *

ACTIVITY HAZARD ANALYSIS – Drilling				
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**RAC**	**Personal Protective Clothing and Equipment**
Groundwater Well Installation/Soil Sampling and Well Development (Cont.)	Pinched/Struck-by/ Caught-in-between	• Where essential ground support personnel must in the area of operating drill rig: – Sufficient separation between ground support personnel and any operating heavy equipment must be maintained. – Isolate equipment swing areas from workers, fixed objects or other equipment. Ground personnel shall avoid positioning themselves between fixed objects, operating equipment. Make/maintain eye contact with operators before approaching equipment. Do not approach equipment from rear or from blind spot of operator. Stay out of the swing radius of operating heavy equipment. – Ensure equipment has operable back-up alarms. • Non-essential personnel must remain out of the operating envelop of the drill rig • Suspended loads (i.e. drill rods) will not pass over workers at any time. Site personnel are prohibited from passing under suspended loads. • Inspect drill rig cables, pull rings and hooks prior to use. • Ensure that all machine guards are in place to prevent contact with drive lines, belts, chains, pinch points or any other sources of mechanical injury. • Unplugging jammed equipment will only be performed when equipment has been shut down, all sources of energy have been isolated, and equipment has been locked/tagged and tested. • Maintenance and repair of equipment that results in the removal of guards or would otherwise put anyone at risk requires lockout of that equipment prior to work.	L	Level D_1 or D_2 Modified PPE *
	Pressure Washing	• Inspect pressure washer before use and confirm dead man switch fully operational. • The wand must always be pointed at the work area. • The Wand trigger should never be tied down in the open position. • Never point the wand at yourself or another worker. • The wand must be at least 42 inches from the trigger to the tip. • The operator must maintain good footing. • Non-operators must remain a safe distance from the operator. • No unauthorized attachment may be made to the unit. • Do not modify the wand. • All leaks or malfunctioning equipment must be repaired immediately or the unit taken out-of-service. • Rain gear (disposal coated chemical suits for Hazwoper operations), 16-inch-high steel-toed rubber boots, safety glasses, hard hat with face shield, and inner and outer nitrile gloves should be worn, at a minimum during pressure washing operations.	L	Level D_1 or D_2 Modified PPE *

ACTIVITY HAZARD ANALYSIS – Drilling				
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**RAC**	**Personal Protective Clothing and Equipment**
Groundwater Well Installation/Soil Sampling and Well Development (Cont.)	Slips, Trips, Falls	• Be aware of poor footing, potential slipping/tripping hazards in the work area, such as wet/steep slopes, stumps/roots, unprotected holes, ditches, rip rap, utilities, ground protrusions (well casings). Observe and avoid areas of unprotected holes, ramps and ground penetrations or protrusions (stumps, roots, holes curbs, utility structures etc). Use sturdy hard toe work boots with sufficient ankle support. • Institute and maintain good housekeeping practices. Clean Work Areas as activities proceed. Clear/removed materials and debris from pathways and commonly traveled areas as soon as possible. • Three points of contact when enter/exiting equipment or when using stairways/ladders.	L	Level D_1 or D_2 Modified PPE *
	Visible Lighting	• Perform tasks in daylight hours whenever possible. If dawn, dusk or dark work is to be performed portable lightly must be provided to sufficient illuminate work area(s).	L	Level D_1 or D_2 Modified PPE *
	Vehicular Traffic	• Shut off and secure site vehicles prior to exiting them. Park on level ground where possible. If parking on an incline, engage parking brake. If the vehicle has a manual transmission, ensure the transmission is in gear (not neutral) and the parking brake is engaged before exiting the vehicle. • Exercise caution when exiting traveled way or parking along street— avoid sudden stops, use flashers, etc. • Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier. • All staff working adjacent to traveled way or within work area must wear reflective/high-visibility safety vests.	M	Level D_1 or D_2 Modified PPE *
	Other	• **Verify that EMS services are available and can respond in a prompt manner prior to the start of work.** • Ensure that all generated GW/Recovery well purge water and IDW is properly collected, containerized, labeled, characterized and disposed of. • Always using a seat belt while driving on military/government facilities. Always observe posted speed limits, traffic signs and signals. Never using a cell phone or two way radio while driving on military/government facilities. Violating these rules may result in loss of military/government facility driving privileges. • Buddy System maintained for all phases of work. • Base or Local Emergency medical Service and Fire Dispatch numbers programmed into cellular phones. Have hospital route maps readily available. • Report all unsafe conditions and acts, injury/illness or property damage to supervisors immediately.	L	Level D_1 or D_2 Modified PPE *

EQUIPMENT REQUIRED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Fire extinguisher (with fuel and electrical sources) • Eye wash (small portable type) • Miscellaneous hand tools. • First Aid/BbPK/CPR shield • Drill Rig • Pressure washer/portable decon. pad • Communication devices	• Visual Inspections of designated work areas identify and address hazardous conditions. • Emergency Response equipment Inspections (Fire Extinguishers, Eye wash First Aid/CPR etc.) • Inspections of hand tools if used. • Drill rig/pressure washer	• Review AHA with all task personnel • Review APP for new site personnel. • 1st Aid/CPR 1st Aid/CPR (2 per site when medical attention a medical facility or physician is more than 5 minutes away to two or more employees. • Supervisors/Field Team (29CFR1910.120(e)(4) • Drill rig operators qualified by previous training or experience. • Training and medical surveillance per 29CFF1910.120. • Competent Person Requirement & Name: NA

DATE PREPPARED: September 20, 2011

PREPARED BY (Name/Title): Butch Stephens

REVIEWED BY (Name/Title): Carl Woods – CH2M HILL Health and Safety Manager

NOTES (Field Notes, Review Comments, etc.):

Overall Risk Code: High

Overall Risk Assessment Code (RAC) (Use highest code)					
Risk Assessment Code (RAC) Matrix					
Severity	**Probability**				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

	RAC Chart
"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.	E = Extremely High Risk H = High Risk
"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible	M = Moderate Risk
Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.	L = Low Risk

	PRINT	SIGNATURE	
Supervisor Name:	____________________	____________________	Date/Time:__________
Safety Officer Name:	____________________	____________________	Date/Time:__________
Site Personnel:	____________________	____________________	Date/Time:__________
	____________________	____________________	Date/Time:__________
	____________________	____________________	Date/Time:__________
	____________________	____________________	Date/Time:__________
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	____________________	____________________	Date/Time:__________

Activity:	IDW Waste Mgmt.	Date:	September 23, 2011
		Project:	Naval Weapons Station CTO-WE29
Description of the Services:	Managing generated waste	Site Supervisor:	Mark Ost
		Site Safety Officer:	Mark Ost (40 Hour HAZWOPER Trained)

ACTIVITY HAZARD ANALYSIS – Management of Generated Waste				
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**RAC**	**Personal Protective Clothing and Equipment**
Management of Generated Waste	Chemical Exposure	• Where contact with free phase petroleum product is POTENTIALLY NOT LIMITED to hands then Modified Level D (D_2) PPE with disposable coveralls is required. • All personnel performing this task shall be trained in accordance with 29CFR1910.120 and be rolled in a medical monitoring program. • Pregnant or potentially pregnant personnel to review Standard of Practice HSE-120, Reproductive Protection before performing any hazardous or potentially hazardous duty. • Do not allow dermal contact or incidental ingestion of impacted soil or groundwater. Skin contact with contaminated water, soils, debris, or equipment shall be avoided at all times. Do not kneel or step in potentially contaminated media (soil or ground water) without first donning proper PPE. • Exercise good hygiene practices. Always wash hands before eating, drinking, smoking and leaving site. Only eat, drink, smoke or chew tobacco in designated areas. • Do not allow on-site haul truck operators to climb into dump bodies without proper PPE. • Adhere to PPE and action monitoring level requirements identified in the HSP.	L	Level D_1 or D_2 Modified PPE * D: Work clothes, reflective vests, hard hat, safety glasses and sturdy hard toed work boots, hearing and hand protection as necessary for task. D_1 : D + hand protection (inner and outer chemical resistant gloves) D_2: D_1+ chemical resistant suits and boot covers, face protection (as needed)
	Slips, Trips, Falls	• Clear walkways work areas of objects • Institute and maintain good housekeeping practices. • Observe/avoid debris in a work area. • Only walk or climb only on surfaces designed for personnel access. • Be aware of poor footing and potential slipping and tripping hazards in the work area (holes, utilities, and wet surfaces). Observe and avoid areas of unprotected holes and ground penetrations or protrusions. Employees walking in ditches, swales adjacent to roads, across undeveloped land or in controlled industrial work/process areas must use caution to prevent slips and falls, which could result in twisted or sprained ankles, knees, and backs. • Sturdy, hard toe work boots that provide ankle support shall be used during field operations.	L	Level D_1 or D_2 Modified PPE *
	Visible Lighting	• Perform tasks in daylight hours. • Do not enter poorly lit areas without first providing portable illumination. • Use only explosion proof lighting/equipment in areas of flammable or combustible gases or liquids. • Use reflective vests/high visibility clothing in high traffic areas or areas with heavy equipment.	L	Level D_1 or D_2 Modified PPE *
	Cuts/Abrasions	• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects. • Do not use razor knives.	L	Level D_1 or D_2 Modified PPE *

ACTIVITY HAZARD ANALYSIS – Management of Generated Waste				
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**RAC**	**Personal Protective Clothing and Equipment**
Management of Generated Waste (Cont.)	Adverse Weather	• Check internet, local TV weather or radio channels for daily forecasts and plan daily work activities accordingly. Have a portable radio available on-site to monitoring local weather or marine forecasts. If on-site internet or radio monitoring are not available, check with home office support personnel to assist with checking internet sources and identifying any severe weather developments that may be projected in the region of the project site. • Frequently observe the eastern skyline for developing rain squalls and thunder storms systems that may develop. • Bring clothing suitable for anticipated daily weather conditions. • Shut down operations during heavy rain/lightning events or high wind conditions. For storms producing lightning, seek safe haven in a grounded structure or rubber vehicle. Implement 30 – 30 rule. Do not seek refuge under trees during electrical or high wind storm events. • Stay away from ravines and gullies during heavy rain events, because of the possibility of flash flood events. • Do not use telephones during electrical storms, except in the case of emergency.	L	Level D_1 or D_2 Modified PPE *
	Fire Prevention	• Be cognizant of Base Fire Prevention requirements. • Provide ABC (or equivalent) fire extinguisher in the work area where electrical or stored fuel is used. • Eliminate ignition sources in work area (open flame, sparks, and electric sources). Where ignition sources are required for work, use only controlled sources (sparkers). • Do not smoke in areas containing flammable/combustible liquids, gases, vapors or fumes. Only smoke in designated areas.	L	Level D_1 or D_2 Modified PPE *
	Sample & IDW Handling	• Caution should be exercised when filling bottles containing acid or base preservatives. Both liquid and vapor phases of acid can cause severe burns. • Following sample collection, sample container lids should be tightened securely to prevent any leaks, and the containers should be rinsed with clean water to ensure that they are free of chemical constituents. Sample activities, sample collection, and equipment decontamination procedures. • Minimize transportation of drums or other containers with IDW. • Sample only labeled drums or drums known to contain IDW. Unknown drums or drums that show evidence of excessive buckling/bulging, corrosion, vapors, crystallization, unusual discoloration or other abnormalities may not be sampled without the evaluation of engineering controls, proper PPE air monitoring equipment and the use properly trained personnel familiar with the sampling of unknown drum contents.	L	Level D_1 or D_2 Modified PPE *
	Hand & Power tools	• Select and use the proper tool for the task. • Tools inspected before use. Maintain all tools in a safe condition	L	Level D_1 or D_2 Modified PPE *

ACTIVITY HAZARD ANALYSIS – Management of Generated Waste				
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**RAC**	**Personal Protective Clothing and Equipment**
Management of Generated Waste (Cont.)	Manual Lifting	• Personnel to notify supervisors or safety representatives of pre-existing medical conditions that may be aggravated or re-injured by lifting activities such that an evaluation of operational procedures may be performed with regard to the required task. • Plan storage and staging to minimize lifting or carrying distances. • Split heavy loads into smaller loads. • Have someone assist with the lift— especially for heavy (> 40lbs.) or awkward loads. (Note: If CH2MHILL employee is not capable of carrying 40 lbs., seek assistance.). • Make sure the path of travel is clear prior to the lift. • Do not lift manhole covers, open/lift hatches or other access points to vessels, tanks or subsurface structures without proper authorization to do so, proper tools and proper personnel protective equipment. • Use drum dollies/carts with a latching mechanism when handling full/loaded drums. Avoid "chimming" drums wherever possible. • Avoid carrying heavy objects above shoulder level.	L	Level D_1 or D_2 Modified PPE *
	Traffic Hazards (pinched, struck by caught in between)	• Shut off and secure site vehicles prior to exiting them. Park on level ground where possible. If parking on an incline, engage parking brake. If the vehicle has a manual transmission, ensure the transmission is in gear (not neutral) and the parking brake is engaged before exiting the vehicle. • Exercise caution when exiting traveled way or parking along street— avoid sudden stops, use flashers, etc. • Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier. • All staff working adjacent to traveled way or within work area must wear reflective/high-visibility safety vests. • Remain aware of factors that influence traffic-related hazards and required controls— sun glare, rain, wind, flash flooding, limited sight-distance, hills, curves, guardrails, width of shoulder (i.e., breakdown lane), etc. • Always remain aware of an escape route -- behind an established barrier, parked vehicle, guardrail, etc. • Always pay attention to moving traffic – never assume drivers are looking out for you. • Work as far from traveled way as possible to avoid creating confusion for drivers. • When workers must face away from traffic, a "buddy system" should be used, where one worker is looking toward traffic. • Work area should be protected by a physical barrier	M	Level D_1 or D_2 Modified PPE *

ACTIVITY HAZARD ANALYSIS – Management of Generated Waste				
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**RAC**	**Personal Protective Clothing and Equipment**
Management of Generated Waste (Cont.)	High Ambient Temperature	• Provide and drink fluids to prevent worker dehydration. • Minimize intake of caffeinated fluids. • Institute a proper work-break regiment in a cool area to avoid heat stress symptoms and overexertion. • Monitor for signs and symptoms of heat stress (maintain use of buddy system) when the ambient air temperature exceeds 70°F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress and especially when wearing disposable or other types of coveralls. 1) Heat Syncope = Sluggishness or fainting while standing erect or immobile in heat. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete*. 2) Heat Rash = Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure. *Treatment = Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.* 3) Heat Cramps = Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake.* 4) Heat exhaustion = Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid thready pulse and low blood pressure; oral temperature normal or low. *Treatment = Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.* 5) Heat Stroke = Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature. *Treatment = Cool rapidly by soaking in cool–but not cold–water. Call ambulance, and get medical attention immediately!*	M	Level D_1 or D_2 Modified PPE * (light colored clothing)

ACTIVITY HAZARD ANALYSIS – Management of Generated Waste				
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**RAC**	**Personal Protective Clothing and Equipment**
Management of Generated Waste (cont.)	Other	• Always using a seat belt while driving on military/government facilities. Always observe posted speed limits, traffic signs and signals. Never using a cell phone or two way radio while driving on military/government facilities. Violating these rules may result in loss of military/government facility driving privileges. • Shut down operations in heavy rain, wind and/or lightning. • Buddy System maintained for all phases of work. • Base or local Emergency Dispatch numbers programmed into cellular phones. Have hospital route maps readily available. • Report all conditions which may create accidents, injury, illness or property damage to supervisors immediately.	L	NA

EQUIPMENT REQUIRED	INSPECTION REQUIREMENTS	TRAINING/AWARENESS REQUIREMENTS
• First Aid Kits/BBBk • Fire extinguisher • Communication devices • Oil absorbent materials (spill cleanup) • Drum dolly	• Visual Inspections of designated work areas identify and address hazardous conditions. • Emergency Response equipment Inspections (Fire Extinguishers, Eye wash First Aid/CPR etc.) • Inspections of hand tools	• Review AHA with all task personnel • Review APP for new site personnel. • Supervisors/FTL, SSHO - 1st Aid/CPR (two people on-site) • Supervisors/FTL, SSHO - SC-HW (29CFR1910.120(e)(4) or equivalent, SCC (10 hr Construction Safety) • All - Training and medical surveillance in accordance 29CFR1910.120 (HAZWOPER) or 29CFR1910.134 (respiratory, as necessary) • Competent Person Requirement & Name: NA

DATE PREPARED: September 23, 2011
DATE REVISED: N/A
PREPARED BY/REVISED BY: Mark Ost
REVIEWED BY (Name/Title): Carl Woods – CH2M HILL Health and Safety Manager

NOTES (Field Notes, Review Comments, etc.):

Overall Risk Code: Moderate

Overall Risk Assessment Code (RAC) (Use highest code)	

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

	RAC Chart
"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.	E = Extremely High Risk H = High Risk
"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible	M = Moderate Risk
Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.	L = Low Risk

	PRINT	SIGNATURE	
Supervisor Name:	______________________	____________________________	Date/Time:__________
Safety Officer Name:	______________________	____________________________	Date/Time:__________
Site Personnel:	______________________	____________________________	Date/Time:__________
	______________________	____________________________	Date/Time:__________
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	______________________	____________________________	Date/Time:__________

CH2MHILL

Pre-Task Safety Plan (PTSP)

Project: _________________________ Location: ________________________Date:___________________________

Supervisor: _________________________________ Job Activity:____

____

Task Personnel:

____

____

____

____

List Tasks:

____

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____

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Tools/Equipment Required for Tasks (ladders, scaffolds, fall protection, cranes/rigging, heavy equipment, power tools):

____

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Potential H&S Hazards, including chemical, physical, safety, biological and environmental (check all that apply):

__ Chemical burns/contact	__ Trench, excavations, cave-ins	__ Ergonomics
__ Pressurized lines/equipment	__ Overexertion	__ Chemical splash
__ Thermal burns	__ Pinch points	__ Poisonous plants/insects
__ Electrical	__ Cuts/abrasions	__ Eye hazards/flying projectile
__ Weather conditions	__ Spills	__ Inhalation hazard
__ Heights/fall > 6 feet	__ Overhead Electrical hazards	__ Heat/cold stress
__ Noise	__ Elevated loads	__ Water/drowning hazard
__ Explosion/fire	__ Slips, trip and falls	__ Heavy equipment
__ Radiation	__ Manual lifting	__ Aerial lifts/platforms
__ Confined space entry	__ Welding/cutting	__ Demolition

Other Potential Hazards (Describe):

____

____

____

____

Hazard Control Measures (Check All That Apply):			
PPE __ Thermal/lined __ Eye __ Dermal/hand __ Hearing __ Respiratory __ Reflective vests __ Flotation device	Protective Systems __ Sloping __ Shoring __ Trench box __ Barricades __ Competent person __ Locate buried utilities __ Daily inspections	Fire Protection __ Fire extinguishers __ Fire watch __ Non-spark tools __ Grounding/bonding __ Intrinsically safe equipment	Electrical __ Lockout/tagout __ Grounded __ Panels covered __ GFCI/extension cords __ Power tools/cord inspected
Fall Protection __ Harness/lanyards __ Adequate anchorage __ Guardrail system __ Covered opening __ Fixed barricades __ Warning system	Air Monitoring __ PID/FID __ Detector tubes __ Radiation __ Personnel sampling __ LEL/O2 __ Other	Proper Equipment __ Aerial lift/ladders/scaffolds __ Forklift/heavy equipment __ Backup alarms __ Hand/power tools __ Crane with current inspection __ Proper rigging __ Operator qualified	Welding & Cutting __ Cylinders secured/capped __ Cylinders separated/upright __ Flash-back arrestors __ No cylinders in CSE __ Flame retardant clothing __ Appropriate goggles
Confined Space Entry __ Isolation __ Air monitoring __ Trained personnel __ Permit completed __ Rescue	Medical/ER __ First-aid kit __ Eye wash __ FA-CPR trained personnel __ Route to hospital	Heat/Cold Stress __ Work/rest regime __ Rest area __ Liquids available __ Monitoring __ Training	Vehicle/Traffic __ Traffic control __ Barricades __ Flags __ Signs
Permits __ Hot work __ Confined space __ Lockout/tagout __ Excavation __ Demolition __ Energized work	Demolition __ Pre-demolition survey __ Structure condition __ Isolate area/utilities __ Competent person __ Hazmat present	Inspections: __ Ladders/aerial lifts __ Lanyards/harness __ Scaffolds __ Heavy equipment __ Cranes and rigging	Training: __ Hazwaste __ Construction __ Competent person __ Task-specific (THA) __ Hazcom
Field Notes:____ ____ ____			

CH2MHILL

Name (Print): _______________________________

Signature: _______________________________ Date: ________________

Safe Behavior Observation Form

☐Federal or ☐Commercial Sector (check one)	☐Construction or ☐Consulting (check one)	
Project Number:	Client/Program:	
Project Name:	Observer:	Date:
Position/Title of worker observed:	Background Information/ comments:	
Task/Observation Observed:		

- ❖ Identify and reinforce safe work practices/behaviors
- ❖ Identify and improve on at-risk practices/acts
- ❖ Identify and improve on practices, conditions, controls, and compliance that eliminate or reduce hazards
- ❖ Proactive PM support facilitates eliminating/reducing hazards (do you have what you need?)
- ❖ Positive, corrective, cooperative, collaborative feedback/recommendations

Actions & Behaviors	Safe	At-Risk	Observations/Comments
Current & accurate Pre-Task Planning/Briefing (Project safety plan, STAC, AHA, PTSP, tailgate briefing, etc., as needed)			**Positive Observations/Safe Work Practices:**
Properly trained/ qualified/experienced			
Tools/equipment available and adequate			
Proper use of tools			**Questionable Activity/Unsafe Condition Observed:**
Barricades/work zone control			
Housekeeping			
Communication			
Work Approach/Habits			
Attitude			
Focus/attentiveness			**Observer's Corrective Actions/Comments:**
Pace			
Uncomfortable/unsafe position			
Inconvenient/unsafe location			
Position/Line of fire			
Apparel (hair, loose clothing, jewelry)			
Repetitive motion			**Observed Worker's Corrective Actions/Comments:**
Other…			

For ES Federal Sector projects please email completed forms to: CH2M HILL ES FED Safe Behavior Observation

CH2M HILL Health and Safety Plan

Attachment 6

Material Safety Data Sheets

(To be included as material is obtained)

Working Alone Standard

CALL – IN CONTACT FORM

Date of site work: _______________ Expected start time: ______________

Name of CH2M HILL employee in the field: _____________________________________

Name of CH2M HILL employee responsible to receive contact: ____________________________

Client Emergency Contact (if any): ____

CH2M HILL employee's contact numbers:

Radio #__________________________

Cell Phone #______________________

Address and Location of work: ____

Directions/Map:

Planned Activity: ____

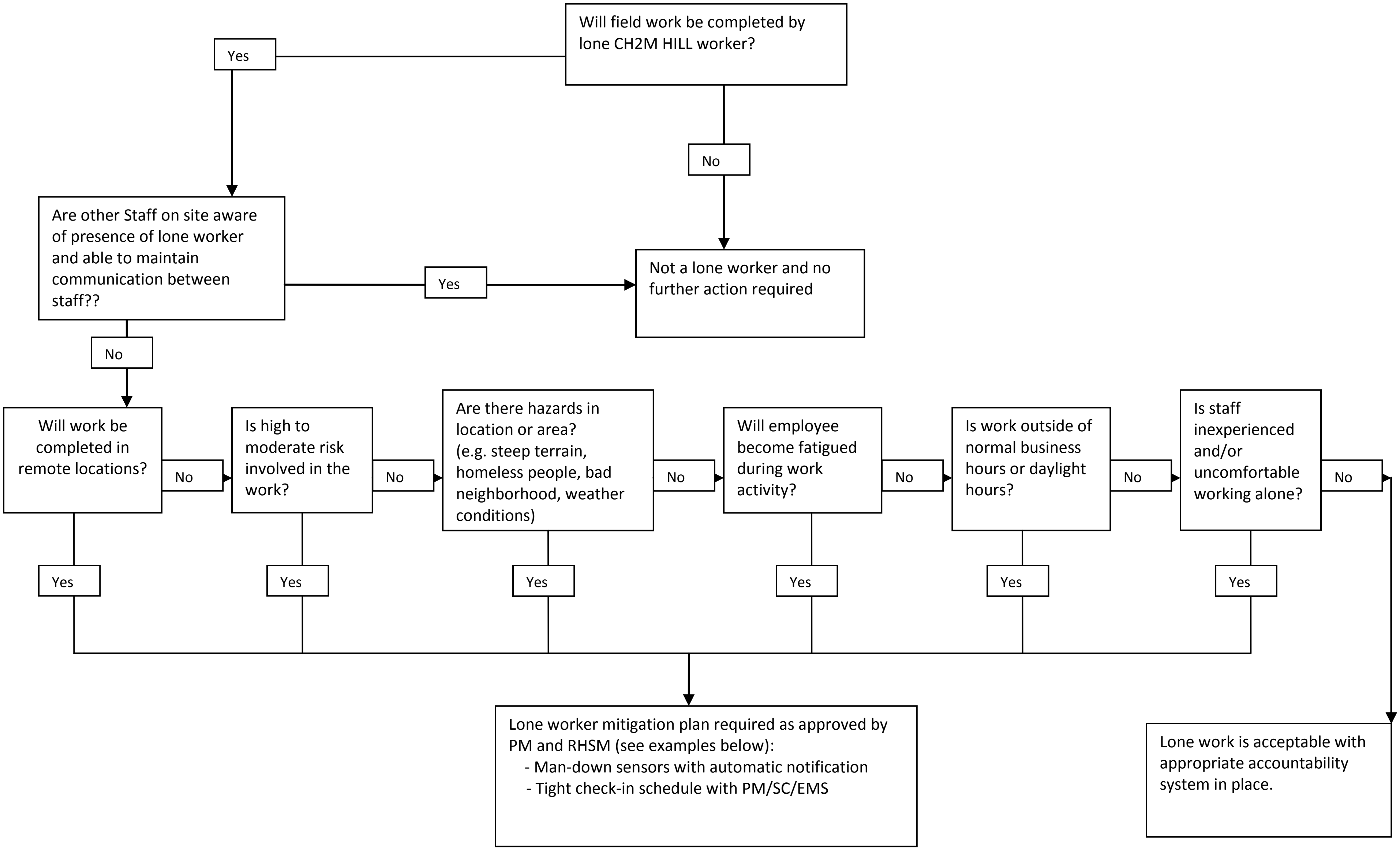
Specified Frequency and time for call in: ____

Time	Verified	Location

If lone worker fails to call in at specified frequency/time:

1) Call worker's radio and cell to determine if an emergency exists.
2) If no reply, immediately call Client security/emergency service if there is one at the site.
3) If there is no client security, call Emergency Services (911). Inform the dispatcher there is a lone worker that cannot be contacted and there may be an emergency on site. Provide the lone worker's name, their last known location, and your contact information.
4) After Emergency Services have been contacted, call the other emergency contacts, Project Manager, and Responsible Health and Safety Manager.

Lone Worker Protocol



Tick Fact Sheet

Tick-Borne Pathogens — A Fact Sheet

Follow Navy CLEAN Biological Prevention Memo

Most of us have heard of Lyme disease or Rocky Mountain Spotted Fever (RMSF), but there are actually six notifiable tick-borne pathogens that present a significant field hazard. In some areas, these account for more than half of our serious field incidents. The following procedures should be applied during any field activity—even in places that are predominantly paved with bordering vegetation.

Hazard Recognition

An important step in controlling tick related hazards is understanding how to identify ticks, their habitats, their geographical locations, and signs and symptoms of tick-borne illnesses.

Tick Identification

There are five varieties of hard-bodied ticks that have been associated with tick-borne pathogens. These include:

- Deer (Black Legged) Tick (eastern and pacific varieties)
- Lone Star Tick
- Dog Tick
- Rocky Mountain Wood Tick

These varieties and their geographical locations are illustrated on the following page.

Tick Habitat

In eastern states, ticks are associated with deciduous forest and habitat containing leaf litter. Leaf litter provides a moist cover from wind, snow, and other elements. In the north-central states, is generally found in heavily wooded areas often surrounded by broad tracts of land cleared for agriculture.

On the Pacific Coast, the bacteria are transmitted to humans by the western black-legged (deer) tick and habitats are more diverse. For this region, ticks have been found in habitats with forest, north coastal scrub, high brush, and open grasslands. Coastal tick populations thrive in areas of high rainfall, but ticks are also found at inland locations.

Illnesses and Signs & Symptoms

There are six notifiable tick-borne pathogens that cause human illness in the United States. These pathogens may be transmitted during a tick bite—normally hours after attachment. The illnesses, presented in approximate order of most common to least, include:

- Lyme (bacteria)
- RMSF (bacteria)
- Ehrlichiosis (bacteria)
- STARI (Southern Tick-Associated Rash Illness) (bacteria)
- Tularemia (Rabbit Fever) (bacteria)
- Babesia (protozoan parasite)

Symptoms will vary based on the illness, and may develop in infected individuals typically between 3 and 30 days after transmission. Some infected individuals will not become ill or may develop only mild symptoms. These illnesses present with some or all of the following signs & symptoms: fever, headache, muscle aches, stiff neck, joint aches, nausea, vomiting, abdominal pain, diarrhea, malaise, weakness, small solid, ring-like, or spotted rashes. The bite site may be red, swollen, or develop ulceration or lesions. For Lyme disease, the bite area will sometimes resemble a target pattern. A variety of long-term symptoms may result if the illness is left untreated, including debilitating effects and death.

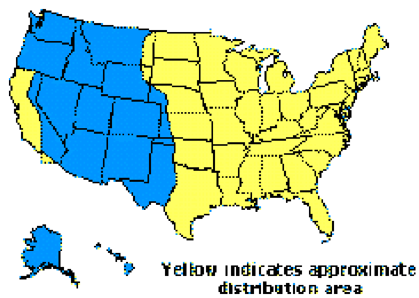
Deer Tick

Distribution of Deer Tick (dark green)

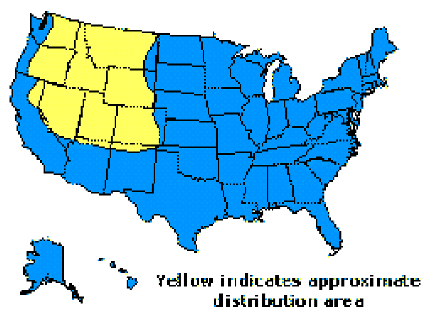
From Left: adult female, adult male, nymph, and larvae Deer Tick (cm scale)

Distribution of Pacific Deer Tick (dark green)

Dog Tick



Rocky Mountain Wood Tick



Hazard Control

The methods for controlling exposure to ticks include, in order of most- to least-preferred:

- Avoiding tick habitats and ceasing operations in heavily infested areas
- Reducing tick abundance through habitat disruption or application of acracide
- Personal protection through use of repellants and protective clothing
- Frequent tick inspections and proper hygiene

Vaccinations are not available and preventative antibiotic treatment after a bite is generally not recommended.

Avoidance and Reduction of Ticks

To the extent practical, tick habitats should be avoided. In areas with significant tick infestation, consider stopping work and withdrawing from area until adequate tick population control can be achieved. Stopping and withdrawing should be considered as seriously as entering an area without proper energy control or with elevated airborne contaminants—tick-borne pathogens present risk of serious illness!

In areas where significant population density or infestation exists, tick reduction should be considered. Tick reduction can be achieved by disrupting tick habitats and/or direct population reduction through the use of tick-toxic pesticides (Damminix, Dursban, Sevin, etc.).

Habitat disruption may include only simple vegetative maintenance such as removing leaf litter and trimming grass and brush. Tick populations can be reduced by between 72 and 100 percent when leaf litter alone is removed. In more heavily infested areas, habitat disruption may include grubbing, tree trimming or removal, and pesticide application (Damminix, Dursban, Sevin, etc.). This approach is practical in smaller, localized areas or perimeter areas that require occasional access. Habitat controls are to be implemented with appropriate health and safety controls, in compliance with applicable environmental requirements, and may be best left to the property owner or tenant or to a licensed pesticide vendor. Caution should be exercised when using chemical repellents or pesticides in or around areas where environmental or industrial media samples will be collected for analysis.

Personal Protection

After other prevention and controls are implemented, personal protection is still necessary to control exposure to ticks. Personal protection must include all of the following steps:

- So that ticks may be easily seen, wear light-colored clothing. Full-body New Tyvek (paper-like disposable coveralls) may also be used
- To prevent ticks from getting underneath clothing tuck pant legs into socks or tape to boots
- Wear long-sleeved shirts, a hat, and high boots
- Apply DEET repellent to exposed skin or clothing per product label
- Apply permethrin repellent to the outside of boots and clothing before wearing, per product label
- Frequently check for ticks and remove from clothing
- At the end of the day, search your entire body for ticks (particularly groin, armpits, neck, and head) and shower
- To prevent pathogen transmission through mucous membranes or broken/cut skin, wash or disinfect hands and/or wear surgical-style nitrile gloves any time ticks are handled

Pregnant individuals and individuals using prescription medications should consult with their physician and/or pharmacists before using chemical repellents. Because human health effects may not be fully known, use of chemical repellents should be kept to a minimum frequency and quantity. Always follow manufacturers' use instructions and precautions. Wash hands after handling, applying, or removing protective gear and clothing. Avoid situations such as hand-to-face contact, eating, drinking, and smoking when applying or using repellents.

Remove and wash clothes per repellent product label. Chemical repellents should not be used on infants and children.

Vaccinations are generally not available for tick-borne pathogens. Although production of the LYMErix™ Lyme disease vaccination has been ceased, vaccination may still be considered under specific circumstances and with concurrence from the consulting physician.

Tick Check

A tick check should be performed after field survey before entering the field vehicle (you do not want to infest your field vehicle with ticks). Have your field partner check your back; the backs of your legs, arms, and neck; and your hairline. Shake off clothing as thorough as possible before entering the vehicle. Once the field day is complete, repeat this procedure and perform a thorough self check.

If a tick has embedded itself into the skin, remove the tick as described below.

Tick Removal

1. Use the tick removal kit obtained through the CH2M HILL Milwaukee warehouse or a fine-tipped tweezers or shield your fingers with a tissue, paper towel, or nitrile gloves.

Tick Bites\Tick Remover.pdf

2. Grasp the tick as close to the skin surface as possible and pull upward with steady, even pressure. Do not twist or jerk the tick; this may cause the mouthparts to break off and remain in the skin. If this happens, remove mouthparts with tweezers. Consult your healthcare provider if infection occurs.

3. Avoid squeezing, crushing or puncturing the body of the tick because its fluids (saliva, hemolymph, gut contents) may contain infectious organisms. Releasing these organisms to the outside of the tick's body or into the bite area may increase the chance of infectious organism transmission.

4. Do not handle the tick with bare hands because infectious agents may enter through mucous membranes or breaks in the skin. This precaution is particularly directed to individuals who remove ticks from domestic animals with unprotected fingers. Children, elderly persons, and immunocompromised persons may be at greater risk of infection and should avoid this procedure.

5. After removing the tick, thoroughly disinfect the bite site and wash your hands with soap and water.

6. Should you wish to save the tick for identification, place it in a plastic bag, with the date of the tick bite, and place in your freezer. It may be used at a later date to assist a physician with making an accurate diagnosis (if you become ill).

Note: Folklore remedies such as petroleum jelly or hot matches do little to encourage a tick to detach from skin. In fact, they may make matters worse by irritating the tick and stimulating it to release additional saliva, increasing the chances of transmitting the pathogen. These methods of tick removal should be avoided. In addition, a number of tick removal devices have been marketed, but none are better than a plain set of fine tipped tweezers.

First-Aid and Medical Treatment

Tick bites should always be treated with first-aid. Clean and wash hands and disinfect the bite site after removing embedded tick. Individuals previously infected with Lyme disease does not confer immunity—re-infection from future tick bites can occur even after a person has contracted a tick-borne disease.

Observed Hazard Form

CH2MHILL

OBSERVED HAZARD FORM

Name/Company of Observer (*optional*):

Date reported:__________________

Time reported:____________________

Contractor/s performing unsafe act or creating unsafe condition:

1. ____

2. ____

3. ____

Unsafe Act or Condition:

____
____
____
____
____
____
____
____
____

Location of Unsafe Act or Condition:

- Injury or illness

Name of CH2M HILL Representative:

____

Corrective Actions Taken: Date: ___________

- _________________________
-
-
-
-

Project Safety Committee Evaluation: Date: ___________

____
____
____
____

Stop Work Order Form

CH2MHILL

Stop Work Order

REPORT PREPARED BY:

Name:	**Title:**	**Signature:**	**Date:**

ISSUE OF NONPERFORMANCE:

Description:	Date of Nonperformance:
	___________________

SUBCONTRACTOR SIGNATURE OF NOTIFICATION:

Name:	**Title:**	**Signature:**	**Date:**

**** Corrective action is to be taken immediately. Note below the action taken, sign and return to CCI.* Work may not resume until authorization is granted by CH2M HILL Constructors, Inc. Representative,***

SUBCONTRACTOR'S CORRECTIVE ACTION

Description:	Date of Nonperformance:
	___________________

SUBCONTRACTOR SIGNATURE OF CORRECTION

Name:	**Title:**	**Signature:**	**Date:**

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 11

Vehicle Accident Guidance

Vehicle Accident Guidance—ESBG

Remember that if you a renting a non-CH2M HILL owned vehicle (short-term rental) in the U.S., you should carry the insurance card from the state where your driver's license is issued.

If you operate a fleet vehicle, carry the insurance card where the vehicle is registered.

Please see link below to print out an insurance card (for **CH2M HILL employees** only). The page shows state-specific restrictions and the definitions of hired, owned, etc., vehicles.

https://communities.int.ch2m.com/legal/insurance/Shared%20Documents/AutoID_Cards.aspx?PageView=Shared

For ALL Vehicles if you are in an accident:

1. If you are injured, call 911 for emergency medical treatment or 1-866-893-2514 to contact the CH2M HILL Occupational Nurse/Physician for minor injuries. If you feel you have not been injured, contact the RHSM for guidance on whether calling the CH2M HILL Occupation Nurse/Physician is applicable.

2. **Call the Police--**For any vehicle accident/damage, it is recommended that the local police (or site security/emergency services if working on a client site that provides such services) be called to determine if a report needs to be filed. In some instances, a report may not be required (during accident alerts, or in public parking lots). Document that the authorities were called and follow up with any guidance they give you. State requirements vary. If a report is filed, obtain a copy.

3. Notify Supervisor, (and PM/RHSM if working on a project site)

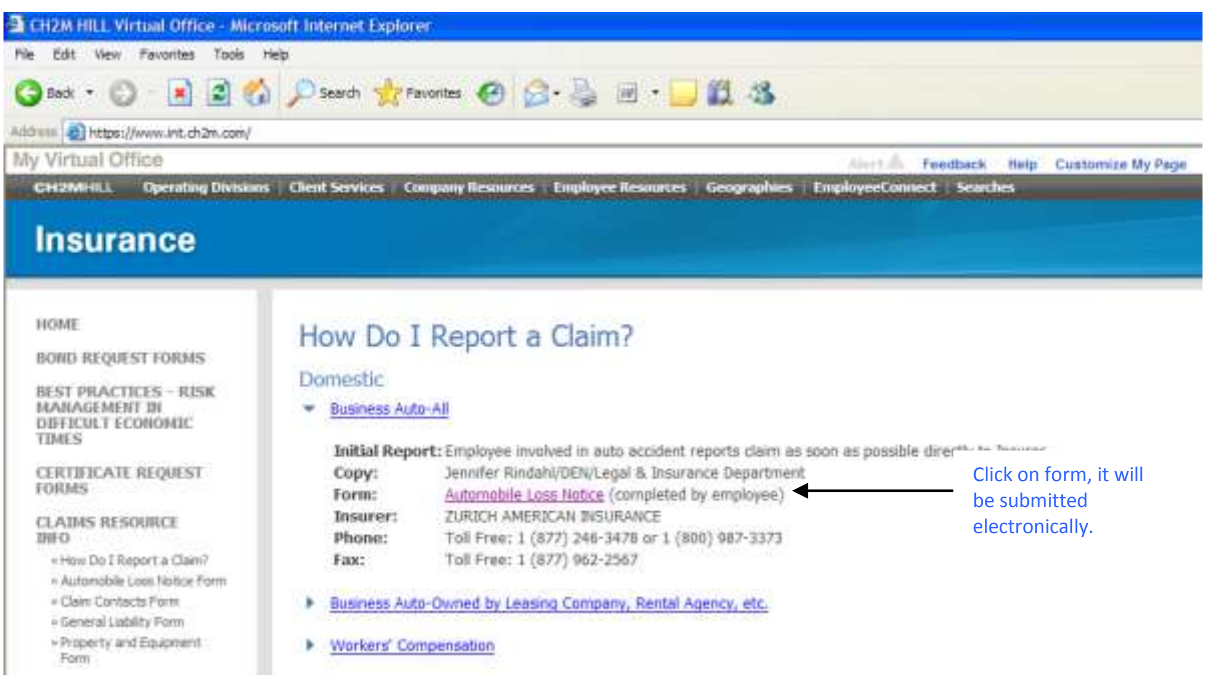
4. Complete a HITS report on the VO.

Additional Steps for FLEET VEHICLES:

Definition: These are vehicles **rented for greater than 90 days** or rentals that are **leased** (either through ARI [Automotive Rental, Inc.] or leases from other companies [older fleet vehicles]).

Report the accident to the following:

1. Fill out and Auto Loss Notice on the Virtual Office (click "Company Resources," then "Corporate Groups," then "Insurance"). See screen shot below.



2. Contact Zurich (1-877-246-3478 or 1-800-987-3373).

3. Contact Linda George/DEN at 720-286-2057.

Note: If you are an ES employee that happens to use an **OMI vehicle** on a project and get into an accident, you must also contact Michelle Garlington/DEN (720-286-4273).

Additional Steps for RENTALS:

1. Fill out and Auto Loss Notice on the Virtual Office (click "Company Resources," then "Corporate Groups," then "Insurance"). See screen shot above.

2. Call 1-800-VISA-911 (**only** if the car has been **rented for less than 31 days**—they provide some additional physical damage coverage in this time period).

3. Call Zurich (1-877-246-3478 or 1-800-987-3373).

4. Call the rental company (Budget, National, Enterprise, etc.).

5. Call Jennifer Rindahl/DEN at 720-286-2449.

For Personally Owned Vehicles (POVs):

CH2M HILL does not provide auto insurance for POVs, it is responsibility of the owner. If you are in a vehicle accident conducting company business, contact the police as above, supervisor, and 911 or CH2M HILL's occupational nurse/physician as stated above. Complete a HITS report. Refer to the Employee Handbook/Policies, assistance for meeting personal insurance deductibles (up to $500) is available with proof of insurance and deductible.

If using your POV for extended project use, notify the PM to make sure a rental car is not needed. Check your insurance policy for guidance on using the POV for business use.

Additional Resources:

Business Auto Insurance Manual
https://www.int.ch2m.com/webuploads/newsgenerator/travel/news/business_auto_manual[1].pdf

Claims Resource Manual
https://www.int.ch2m.com/intrnl/voffice/corp/insurance/InsHome.asp

Appendix F
Ecological Screening Values

Appendix F
Ecological Screening Values (ESVs) for Soil

Analytical Group	Chemical	ESV	Units	Reference	Comments
Explosives	1,3,5-Trinitrobenzene	NSV	--	--	
Explosives	1,3-Dinitrobenzene	NSV	--	--	
Explosives	2,4,6-Trinitrotoluene	10,000	ug/kg	Talmage et al. 1999	Plant
Explosives	2,4-Dinitrotoluene	11,000	ug/kg	NRCC 2006	Plant/Invertebrate
Explosives	2,6-Dinitrotoluene	8,500	ug/kg	NRCC 2006	Plant/Invertebrate
Explosives	2-Amino-4,6-dinitrotoluene	80,000	ug/kg	Talmage et al. 1999	Plant
Explosives	2-Nitrotoluene	NSV	--	--	
Explosives	3,5-Dinitroaniline	NSV	--	--	
Explosives	3-Nitrotoluene	NSV	--	--	
Explosives	4-Amino-2,6-dinitrotoluene	80,000	ug/kg	2-Amino-4,6-dinitrotoluene	Plant
Explosives	4-Nitrotoluene	NSV	--	--	
Explosives	HMX	10,000	ug/kg	Talmage et al. 1999	Invertebrate
Explosives	Nitrobenzene	2,260	ug/kg	Efroymson et al. 1997b	LC50 of 226,000; UF of 100
Explosives	Perchlorate	1,000	ug/kg	USEPA 2002	Invertebrate
Explosives	RDX	10,000	ug/kg	Talmage et al. 1999	Invertebrate
Explosives	Tetryl	10,000	ug/kg	Talmage et al. 1999	Plant
Inorganics	Aluminum	pH < 5.5	--	USEPA 2003a	Eco-SSL
Inorganics	Antimony	78.0	mg/kg	USEPA 2005a	Eco-SSL - Invertebrate
Inorganics	Arsenic	18.0	mg/kg	USEPA 2005b	Eco-SSL - Plant
Inorganics	Barium	330	mg/kg	USEPA 2005c	Eco-SSL - Invertebrate
Inorganics	Beryllium	40.0	mg/kg	USEPA 2005d	Eco-SSL - Invertebrate
Inorganics	Cadmium	32.0	mg/kg	USEPA 2005e	Eco-SSL - Plant
Inorganics	Calcium	NSV	--	--	
Inorganics	Chromium	64.0	mg/kg	CCME 2007	Soil Quality Guideline
Inorganics	Cobalt	13.0	mg/kg	USEPA 2005f	Eco-SSL - Plant
Inorganics	Copper	70.0	mg/kg	USEPA 2007a	Eco-SSL - Plant
Inorganics	Cyanide	15.8	mg/kg	MHSPE 2000	eomean of target/intervention - complex
Inorganics	Iron	5 < pH > 8	--	USEPA 2003b	Eco-SSL
Inorganics	Lead	120	mg/kg	USEPA 2005g	Eco-SSL - Plant
Inorganics	Magnesium	NSV	--	--	
Inorganics	Manganese	220	mg/kg	USEPA 2007b	Eco-SSL - Plant
Inorganics	Mercury	0.10	mg/kg	Efroymson et al. 1997b	Invertebrate

Appendix F
Ecological Screening Values (ESVs) for Soil

Analytical Group	Chemical	ESV	Units	Reference	Comments
Inorganics	Nickel	38.0	mg/kg	USEPA 2007c	Eco-SSL - Plant
Inorganics	Potassium	NSV	--	--	
Inorganics	Selenium	0.52	mg/kg	USEPA 2007d	Eco-SSL - Plant
Inorganics	Silver	560	mg/kg	USEPA 2006a	Eco-SSL - Plant
Inorganics	Sodium	NSV	--	--	
Inorganics	Thallium	1.00	mg/kg	Efroymson et al. 1997a	Plant
Inorganics	Vanadium	130	mg/kg	CCME 2007	Soil Quality Guideline
Inorganics	Zinc	120	mg/kg	USEPA 2007e	Eco-SSL - Invertebrate
Pesticides	4,4'-DDD	583	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
Pesticides	4,4'-DDE	114	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
Pesticides	4,4'-DDT	100	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
Pesticides	Aldrin	3.63	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
Pesticides	alpha-BHC	226	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
Pesticides	alpha-Chlordane	11.0	ug/kg	MHSPE 2000	Geomean of target/intervention
Pesticides	beta-BHC	342	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
Pesticides	delta-BHC	226	ug/kg	alpha-BHC	
Pesticides	Dieldrin	10.5	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
Pesticides	Endosulfan I	6.32	ug/kg	MHSPE 2000	Geomean of target/intervention
Pesticides	Endosulfan II	6.32	ug/kg	MHSPE 2000	Geomean of target/intervention
Pesticides	Endosulfan sulfate	6.32	ug/kg	Endosulfan	
Pesticides	Endrin	1.95	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
Pesticides	Endrin aldehyde	1.95	ug/kg	Endrin	
Pesticides	Endrin ketone	1.95	ug/kg	Endrin	
Pesticides	gamma-BHC (Lindane)	7.75	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
Pesticides	gamma-Chlordane	11.0	ug/kg	MHSPE 2000	Geomean of target/intervention
Pesticides	Heptachlor	52.9	ug/kg	MHSPE 2000	Geomean of target/intervention
Pesticides	Heptachlor epoxide	52.9	ug/kg	Heptachlor	
Pesticides	Methoxychlor	500	ug/kg	Beyer 1990	B value
Pesticides	Toxaphene	500	ug/kg	Beyer 1990	B value
PCBs	Aroclor-1016	8,000	ug/kg	Efroymson et al. 1997a	Lowest EC50 (40,000); UF of 5
PCBs	Aroclor-1221	8,000	ug/kg	Efroymson et al. 1997a	Lowest EC50 (40,000); UF of 5
PCBs	Aroclor-1232	8,000	ug/kg	Efroymson et al. 1997a	Lowest EC50 (40,000); UF of 5

Appendix F

Ecological Screening Values (ESVs) for Soil

Analytical Group	Chemical	ESV	Units	Reference	Comments
PCBs	Aroclor-1242	8,000	ug/kg	Efroymson et al. 1997a	Lowest EC50 (40,000); UF of 5
PCBs	Aroclor-1248	8,000	ug/kg	Efroymson et al. 1997a	Lowest EC50 (40,000); UF of 5
PCBs	Aroclor-1254	8,000	ug/kg	Efroymson et al. 1997a	Lowest EC50 (40,000); UF of 5
PCBs	Aroclor-1260	8,000	ug/kg	Efroymson et al. 1997a	Lowest EC50 (40,000); UF of 5
VOCs	1,1,1-Trichloroethane	1,025	ug/kg	MHSPE 2000	Geomean of target/intervention
VOCs	1,1,2,2-Tetrachloroethane	5,000	ug/kg	Beyer 1990; CCME 2007	B value; IRC
VOCs	1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	NSV	--	--	
VOCs	1,1,2-Trichloroethane	2,000	ug/kg	MHSPE 2000	Geomean of target/intervention
VOCs	1,1-Dichloroethane	548	ug/kg	MHSPE 2000	Geomean of target/intervention
VOCs	1,1-Dichloroethene	173	ug/kg	MHSPE 2000	Geomean of target/intervention
VOCs	1,2,3-Trichlorobenzene	1,150	ug/kg	Efroymson et al. 1997b	LC50 of 115,000; UF of 100
VOCs	1,2,4-Trichlorobenzene	1,270	ug/kg	Efroymson et al. 1997b	LC50 of 127,000; UF of 100
VOCs	1,2-Dibromo-3-chloropropane	NSV	--	--	
VOCs	1,2-Dibromoethane	300	ug/kg	CCME 2007	IRC
VOCs	1,2-Dichlorobenzene	1,000	ug/kg	Beyer 1990; CCME 2007	B value; IRC
VOCs	1,2-Dichloroethane	2,190	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
VOCs	1,2-Dichloropropane	38,800	ug/kg	Efroymson et al. 1997b	LC50 of 3,880,000; UF of 100
VOCs	1,3-Dichlorobenzene	1,000	ug/kg	Beyer 1990; CCME 2007	B value; IRC
VOCs	1,4-Dichlorobenzene	1,280	ug/kg	Efroymson et al. 1997b	LC50 of 128,000; UF of 100
VOCs	2-Butanone	NSV	--	--	
VOCs	2-Hexanone	NSV	--	--	
VOCs	4-Methyl-2-pentanone	NSV	--	--	
VOCs	Acetone	NSV	--	--	
VOCs	Benzene	1,140	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
VOCs	Bromochloromethane	NSV	--	--	
VOCs	Bromodichloromethane	NSV	--	--	
VOCs	Bromoform	300	ug/kg	CCME 2007	Plant; IRC
VOCs	Bromomethane	NSV	--	--	
VOCs	Carbon disulfide	NSV	--	--	
VOCs	Carbon tetrachloride	3,400	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
VOCs	Chlorobenzene	2,400	ug/kg	Efroymson et al. 1997b	LC50 of 240,000; UF of 100

Appendix F
Ecological Screening Values (ESVs) for Soil

Analytical Group	Chemical	ESV	Units	Reference	Comments
VOCs	Chloroethane	5,000	ug/kg	CCME 2007	IRC
VOCs	Chloroform	1,844	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
VOCs	Chloromethane	5,000	ug/kg	CCME 2007	IRC
VOCs	cis-1,2-Dichloroethene	447	ug/kg	MHSPE 2000	Geomean of target/intervention
VOCs	cis-1,3-Dichloropropene	5,000	ug/kg	Beyer 1990; CCME 2007	B value; IRC
VOCs	Cyclohexane	6,000	ug/kg	Beyer 1990	B value
VOCs	Dibromochloromethane	NSV	--	--	
VOCs	Dichlorodifluoromethane(Freon-12)	NSV	--	--	
VOCs	Ethylbenzene	1,815	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
VOCs	Isopropylbenzene	NSV	--	--	
VOCs	m- and p-Xylene	1,300	ug/kg	Total xylenes	
VOCs	Methyl acetate	NSV	--	--	
VOCs	Methylcyclohexane	NSV	--	--	
VOCs	Methylene chloride	1,250	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
VOCs	Methyl-tert-butyl ether (MTBE)	NSV	--	--	
VOCs	o-Xylene	1,300	ug/kg	Total xylenes	
VOCs	Styrene	64,000	ug/kg	Efroymson et al. 1997a	EC50 (320,000); UF of 5
VOCs	Tetrachloroethene	179	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
VOCs	Toluene	40,000	ug/kg	Efroymson et al. 1997a	EC50 (200,000); UF of 5
VOCs	trans-1,2-Dichloroethene	447	ug/kg	MHSPE 2000	Geomean of target/intervention
VOCs	trans-1,3-Dichloropropene	5,000	ug/kg	Beyer 1990; CCME 2007	B value; IRC
VOCs	Trichloroethene	500	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
VOCs	Trichlorofluoromethane(Freon-11)	NSV	--	--	
VOCs	Vinyl chloride	412	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC
VOCs	Xylene, total	1,300	ug/kg	MHSPE 2000; 2001	Geomean of target/SRC

NSV - No Screening Value

Appendix F
Ecological Screening Values (ESVs) for Marine Sediment

Analytical Group	Chemical	Type	ESV	Units	TOC (%)	Reference	Comment
Explosives	1,3,5-Trinitrobenzene	Marine	7,000	ug/kg		NAVFAC 2007	NOEC
Explosives	1,3-Dinitrobenzene	Marine	NSV	--		--	
Explosives	2,4,6-Trinitrotoluene	Marine	20,000	ug/kg		NAVFAC 2007	NOEC
Explosives	2,4-Dinitrotoluene	Marine	3,184	ug/kg	1	NAVFAC 2007	EqP
Explosives	2,6-Dinitrotoluene	Marine	549	ug/kg		Nipper et al. 2002	NOEC
Explosives	2-Amino-4,6-dinitrotoluene	Marine	NSV	--		--	
Explosives	2-Nitrotoluene	Marine	NSV	--		--	
Explosives	3,5-Dinitroaniline	Marine	NSV	--		--	
Explosives	3-Nitrotoluene	Marine	NSV	--		--	
Explosives	4-Amino-2,6-dinitrotoluene	Marine	NSV	--		--	
Explosives	4-Nitrotoluene	Marine	NSV	--		--	
Explosives	HMX	Marine	115,000	ug/kg		NAVFAC 2007	NOEC
Explosives	Nitrobenzene	Marine	21.0	ug/kg		Buchman 2008	AET
Explosives	Perchlorate	Marine	NSV	--		--	
Explosives	RDX	Marine	891,000	ug/kg		NAVFAC 2007	NOEC
Explosives	Tetryl	Marine	72.0	ug/kg		Nipper et al. 2002	NOEC
Inorganics	Aluminum	Marine	18,000	mg/kg		Buchman 2008	AET
Inorganics	Antimony	Marine	2.00	mg/kg		Long and Morgan 1990	ER-L
Inorganics	Arsenic	Marine	8.20	mg/kg		Long et al. 1995	ER-L
Inorganics	Barium	Marine	48.0	mg/kg		Buchman 2008	AET
Inorganics	Beryllium	Marine	NSV	--		--	
Inorganics	Cadmium	Marine	1.20	mg/kg		Long et al. 1995	ER-L
Inorganics	Calcium	Marine	NSV	--		--	
Inorganics	Chromium	Marine	81.0	mg/kg		Long et al. 1995	ER-L
Inorganics	Cobalt	Marine	10.0	mg/kg		Buchman 2008	AET
Inorganics	Copper	Marine	34.0	mg/kg		Long et al. 1995	ER-L
Inorganics	Cyanide	Marine	NSV	--		--	
Inorganics	Iron	Marine	220,000	mg/kg		Buchman 2008	AET
Inorganics	Lead	Marine	46.7	mg/kg		Long et al. 1995	ER-L
Inorganics	Magnesium	Marine	NSV	--		--	
Inorganics	Manganese	Marine	260	mg/kg		Buchman 2008	AET
Inorganics	Mercury	Marine	0.15	mg/kg		Long et al. 1995	ER-L

Appendix F
Ecological Screening Values (ESVs) for Marine Sediment

Analytical Group	Chemical	Type	ESV	Units	TOC (%)	Reference	Comment
Inorganics	Nickel	Marine	20.9	mg/kg		Long et al. 1995	ER-L
Inorganics	Potassium	Marine	NSV	--		--	
Inorganics	Selenium	Marine	1.00	mg/kg		Buchman 2008	AET
Inorganics	Silver	Marine	1.00	mg/kg		Long et al. 1995	ER-L
Inorganics	Sodium	Marine	NSV	--		--	
Inorganics	Thallium	Marine	NSV	--		--	
Inorganics	Vanadium	Marine	57.0	mg/kg		Buchman 2008	AET
Inorganics	Zinc	Marine	150	mg/kg		Long et al. 1995	ER-L
Pesticides	4,4'-DDD	Marine	1.22	ug/kg		MacDonald 1994	TEL
Pesticides	4,4'-DDE	Marine	2.20	ug/kg		Long et al. 1995	ER-L
Pesticides	4,4'-DDT	Marine	1.19	ug/kg		MacDonald 1994	TEL
Pesticides	Aldrin	Marine	9.50	ug/kg		Buchman 2008	AET
Pesticides	alpha-BHC	Marine	1,360	ug/kg	1	USEPA 2006b	EqP
Pesticides	alpha-Chlordane	Marine	2.26	ug/kg		MacDonald 1994	TEL
Pesticides	beta-BHC	Marine	1,360	ug/kg	1	alpha-BHC	EqP
Pesticides	delta-BHC	Marine	1,360	ug/kg	1	alpha-BHC	EqP
Pesticides	Dieldrin	Marine	0.72	ug/kg		MacDonald 1994	TEL; Cited in USEPA 2006b
Pesticides	Endosulfan I	Marine	0.51	ug/kg	1	USEPA 2008	EqP
Pesticides	Endosulfan II	Marine	2.40	ug/kg	1	USEPA 2008	EqP
Pesticides	Endosulfan sulfate	Marine	0.36	ug/kg	1	USEPA 2006b	EqP
Pesticides	Endrin	Marine	3.50	ug/kg	1	USEPA 1996	EqP
Pesticides	Endrin aldehyde	Marine	3.50	ug/kg	1	Endrin	EqP
Pesticides	Endrin ketone	Marine	3.50	ug/kg	1	Endrin	EqP
Pesticides	gamma-BHC (Lindane)	Marine	0.32	ug/kg		MacDonald 1994	TEL; Cited in USEPA 2006b
Pesticides	gamma-Chlordane	Marine	2.26	ug/kg		MacDonald 1994	TEL; Cited in USEPA 2006b
Pesticides	Heptachlor	Marine	0.30	ug/kg		Buchman 2008	AET
Pesticides	Heptachlor epoxide	Marine	NSV	--		--	
Pesticides	Methoxychlor	Marine	29.6	ug/kg	1	USEPA 2006b	EqP
Pesticides	Toxaphene	Marine	540	ug/kg	1	USEPA 2008	EqP
PCBs	Aroclor-1016	Marine	48.0	ug/kg		MacDonald et al. 2000	TEC
PCBs	Aroclor-1221	Marine	48.0	ug/kg		MacDonald et al. 2000	TEC
PCBs	Aroclor-1232	Marine	48.0	ug/kg		MacDonald et al. 2000	TEC

Appendix F
Ecological Screening Values (ESVs) for Marine Sediment

Analytical Group	Chemical	Type	ESV	Units	TOC (%)	Reference	Comment
PCBs	Aroclor-1242	Marine	48.0	ug/kg		MacDonald et al. 2000	TEC
PCBs	Aroclor-1248	Marine	48.0	ug/kg		MacDonald et al. 2000	TEC
PCBs	Aroclor-1254	Marine	63.3	ug/kg		CCME 2002	ISQG
PCBs	Aroclor-1260	Marine	48.0	ug/kg		MacDonald et al. 2000	TEC
VOCs	1,1,1-Trichloroethane	Marine	856	ug/kg	1	USEPA 2006b	EqP
VOCs	1,1,2,2-Tetrachloroethane	Marine	202	ug/kg	1	USEPA 2006b	EqP
VOCs	1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	Marine	NSV	--		--	
VOCs	1,1,2-Trichloroethane	Marine	570	ug/kg	1	USEPA 2006b	EqP
VOCs	1,1-Dichloroethane	Marine	NSV	--		--	
VOCs	1,1-Dichloroethene	Marine	2,782	ug/kg	1	USEPA 2006b	EqP
VOCs	1,2,3-Trichlorobenzene	Marine	NSV	--		--	
VOCs	1,2,4-Trichlorobenzene	Marine	473	ug/kg	1	USEPA 2006b	EqP
VOCs	1,2-Dibromo-3-chloropropane	Marine	NSV	--		--	
VOCs	1,2-Dibromoethane	Marine	NSV	--		--	
VOCs	1,2-Dichlorobenzene	Marine	989	ug/kg	1	USEPA 2006b	EqP
VOCs	1,2-Dichloroethane	Marine	NSV	--		--	
VOCs	1,2-Dichloropropane	Marine	NSV	--		--	
VOCs	1,3-Dichlorobenzene	Marine	842	ug/kg	1	USEPA 2006b	EqP
VOCs	1,4-Dichlorobenzene	Marine	110	ug/kg		Buchman 2008	AET
VOCs	2-Butanone	Marine	NSV	--		--	
VOCs	2-Hexanone	Marine	NSV	--		--	
VOCs	4-Methyl-2-pentanone	Marine	NSV	--		--	
VOCs	Acetone	Marine	NSV	--		--	
VOCs	Benzene	Marine	137	ug/kg	1	USEPA 2006b	EqP
VOCs	Bromochloromethane	Marine	NSV	--		--	
VOCs	Bromodichloromethane	Marine	NSV	--		--	
VOCs	Bromoform	Marine	1,308	ug/kg	1	USEPA 2006b	EqP
VOCs	Bromomethane	Marine	NSV	--		--	
VOCs	Carbon disulfide	Marine	NSV	--		--	
VOCs	Carbon tetrachloride	Marine	7,244	ug/kg	1	USEPA 2006b	EqP
VOCs	Chlorobenzene	Marine	162	ug/kg	1	USEPA 2006b	EqP

Appendix F
Ecological Screening Values (ESVs) for Marine Sediment

Analytical Group	Chemical	Type	ESV	Units	TOC (%)	Reference	Comment
VOCs	Chloroethane	Marine	NSV	--		--	
VOCs	Chloroform	Marine	NSV	--		--	
VOCs	Chloromethane	Marine	NSV	--		--	
VOCs	cis-1,2-Dichloroethene	Marine	NSV	--		--	
VOCs	cis-1,3-Dichloropropene	Marine	7.31	ug/kg	1	USEPA 2006b	EqP
VOCs	Cyclohexane	Marine	NSV	--		--	
VOCs	Dibromochloromethane	Marine	NSV	--		--	
VOCs	Dichlorodifluoromethane(Freon-12)	Marine	NSV	--		--	
VOCs	Ethylbenzene	Marine	305	ug/kg	1	USEPA 2006b	EqP
VOCs	Isopropylbenzene	Marine	NSV	--		--	
VOCs	m- and p-Xylene	Marine	NSV	--		--	
VOCs	Methyl acetate	Marine	NSV	--		--	
VOCs	Methylcyclohexane	Marine	NSV	--		--	
VOCs	Methylene chloride	Marine	NSV	--		--	
VOCs	Methyl-tert-butyl ether (MTBE)	Marine	NSV	--		--	
VOCs	o-Xylene	Marine	NSV	--		--	
VOCs	Styrene	Marine	7,069	ug/kg	1	USEPA 2006b	EqP
VOCs	Tetrachloroethene	Marine	57.0	ug/kg		Buchman 2008	AET
VOCs	Toluene	Marine	1,086	ug/kg	1	USEPA 2006b	EqP
VOCs	trans-1,2-Dichloroethene	Marine	NSV	--		--	
VOCs	trans-1,3-Dichloropropene	Marine	7.31	ug/kg	1	USEPA 2006b	EqP
VOCs	Trichloroethene	Marine	41.0	ug/kg		Buchman 2008	AET
VOCs	Trichlorofluoromethane(Freon-11)	Marine	NSV	--		--	
VOCs	Vinyl chloride	Marine	NSV	--		--	
VOCs	Xylene, total	Marine	NSV	--		--	

NSV - No Screening Value

Appendix F
Ecological Screening Values (ESVs) for Water

Analytical Group	Chemical	Type	ESV	Units	Reference	Comments
Explosives	1,3,5-Trinitrobenzene	Marine	15.0	ug/L	Nipper et al. 2001	NOEC; algae
Explosives	1,3-Dinitrobenzene	Marine	180	ug/L	Nipper et al. 2001	NOEC; algae
Explosives	2,4,6-Trinitrotoluene	Marine	100	ug/L	USEPA 2006b	
Explosives	2,4-Dinitrotoluene	Marine	480	ug/L	Nipper et al. 2001	NOEC; algae
Explosives	2,6-Dinitrotoluene	Marine	1,000	ug/L	Nipper et al. 2001	NOEC; algae
Explosives	2-Amino-4,6-dinitrotoluene	Marine	NSV	--	--	
Explosives	2-Nitrotoluene	Marine	NSV	--	--	
Explosives	3,5-Dinitroaniline	Marine	NSV	--	--	
Explosives	3-Nitrotoluene	Marine	NSV	--	--	
Explosives	4-Amino-2,6-dinitrotoluene	Marine	NSV	--	--	
Explosives	4-Nitrotoluene	Marine	NSV	--	--	
Explosives	HMX	Marine	NSV	--	--	
Explosives	Nitrobenzene	Marine	66.8	ug/L	USEPA 2001	
Explosives	Perchlorate	Marine	NSV	--	--	
Explosives	RDX	Marine	5,000	ug/L	Nipper et al. 2001	NOEC; algae
Explosives	Tetryl	Marine	8.00	ug/L	Nipper et al. 2001	NOEC; polychaete
Filtered Metals	Aluminum	Marine	NSV	--	--	
Filtered Metals	Antimony	Marine	500	ug/L	USEPA 2006b	
Filtered Metals	Arsenic	Marine	36.0	ug/L	USEPA 2009	AWQC
Filtered Metals	Barium	Marine	200	ug/L	Buchman 2008	British Columbia
Filtered Metals	Beryllium	Marine	100	ug/L	Buchman 2008	British Columbia
Filtered Metals	Cadmium	Marine	8.80	ug/L	USEPA 2009	AWQC
Filtered Metals	Calcium	Marine	NSV	--	--	
Filtered Metals	Chromium	Marine	50.0	ug/L	USEPA 2009	AWQC
Filtered Metals	Cobalt	Marine	NSV	--	--	
Filtered Metals	Copper	Marine	3.10	ug/L	USEPA 2009	AWQC
Filtered Metals	Iron	Marine	NSV	--	--	
Filtered Metals	Lead	Marine	8.10	ug/L	USEPA 2009	AWQC
Filtered Metals	Magnesium	Marine	NSV	--	--	
Filtered Metals	Manganese	Marine	100	ug/L	Buchman 2008	British Columbia
Filtered Metals	Mercury	Marine	0.94	ug/L	USEPA 2009	AWQC
Filtered Metals	Nickel	Marine	8.20	ug/L	USEPA 2009	AWQC

Appendix F
Ecological Screening Values (ESVs) for Water

Analytical Group	Chemical	Type	ESV	Units	Reference	Comments
Filtered Metals	Potassium	Marine	NSV	--	--	
Filtered Metals	Selenium	Marine	71.0	ug/L	USEPA 2009	AWQC
Filtered Metals	Silver	Marine	0.23	ug/L	USEPA 2001	
Filtered Metals	Sodium	Marine	NSV	--	--	
Filtered Metals	Thallium	Marine	21.3	ug/L	USEPA 2001	
Filtered Metals	Vanadium	Marine	50.0	ug/L	Buchman 2008	British Columbia
Filtered Metals	Zinc	Marine	81.0	ug/L	USEPA 2009	AWQC
Inorganics	Aluminum	Marine	NSV	--	--	
Inorganics	Antimony	Marine	500	ug/L	USEPA 2006b	
Inorganics	Arsenic	Marine	36.0	ug/L	USEPA 2009	AWQC
Inorganics	Barium	Marine	200	ug/L	Buchman 2008	British Columbia
Inorganics	Beryllium	Marine	100	ug/L	Buchman 2008	British Columbia
Inorganics	Cadmium	Marine	8.85	ug/L	USEPA 2009	AWQC
Inorganics	Calcium	Marine	NSV	--	--	
Inorganics	Chromium	Marine	50.4	ug/L	USEPA 2009	AWQC
Inorganics	Cobalt	Marine	NSV	--	--	
Inorganics	Copper	Marine	3.73	ug/L	USEPA 2009	AWQC
Inorganics	Cyanide	Marine	1.00	ug/L	USEPA 2009	AWQC
Inorganics	Iron	Marine	NSV	--	--	
Inorganics	Lead	Marine	8.52	ug/L	USEPA 2009	AWQC
Inorganics	Magnesium	Marine	NSV	--	--	
Inorganics	Manganese	Marine	100	ug/L	Buchman 2008	British Columbia
Inorganics	Mercury	Marine	1.11	ug/L	USEPA 2009	AWQC
Inorganics	Nickel	Marine	8.28	ug/L	USEPA 2009	AWQC
Inorganics	Potassium	Marine	NSV	--	--	
Inorganics	Selenium	Marine	71.1	ug/L	USEPA 2009	AWQC
Inorganics	Silver	Marine	0.23	ug/L	USEPA 2001	
Inorganics	Sodium	Marine	NSV	--	--	
Inorganics	Thallium	Marine	21.3	ug/L	USEPA 2001	
Inorganics	Vanadium	Marine	50.0	ug/L	Buchman 2008	British Columbia
Inorganics	Zinc	Marine	85.6	ug/L	USEPA 2009	AWQC
Pesticides	4,4'-DDD	Marine	0.025	ug/L	USEPA 2001	

Appendix F
Ecological Screening Values (ESVs) for Water

Analytical Group	Chemical	Type	ESV	Units	Reference	Comments
Pesticides	4,4'-DDE	Marine	0.14	ug/L	USEPA 2001	
Pesticides	4,4'-DDT	Marine	0.0065	ug/L	USEPA 2006b	
Pesticides	Aldrin	Marine	0.13	ug/L	USEPA 2001	
Pesticides	alpha-BHC	Marine	25.0	ug/L	USEPA 2006b	
Pesticides	alpha-Chlordane	Marine	0.004	ug/L	USEPA 2009	FRV - AWQC
Pesticides	beta-BHC	Marine	25.0	ug/L	alpha-BHC	
Pesticides	delta-BHC	Marine	25.0	ug/L	alpha-BHC	
Pesticides	Dieldrin	Marine	0.11	ug/L	USEPA 1996	FCV
Pesticides	Endosulfan I	Marine	0.0087	ug/L	USEPA 2009	AWQC
Pesticides	Endosulfan II	Marine	0.0087	ug/L	USEPA 2009	AWQC
Pesticides	Endosulfan sulfate	Marine	0.0087	ug/L	USEPA 2009	AWQC
Pesticides	Endrin	Marine	0.01	ug/L	USEPA 1996	FCV
Pesticides	Endrin aldehyde	Marine	0.01	ug/L	Endrin	
Pesticides	Endrin ketone	Marine	0.01	ug/L	Endrin	
Pesticides	gamma-BHC (Lindane)	Marine	0.016	ug/L	USEPA 2001	
Pesticides	gamma-Chlordane	Marine	0.004	ug/L	USEPA 2009	FRV - AWQC
Pesticides	Heptachlor	Marine	0.0036	ug/L	USEPA 2009	FRV - AWQC
Pesticides	Heptachlor epoxide	Marine	0.0036	ug/L	USEPA 2009	FRV - AWQC
Pesticides	Methoxychlor	Marine	0.03	ug/L	USEPA 2009	AWQC
Pesticides	Toxaphene	Marine	0.21	ug/L	USEPA 1996	FCV
PCBs	Aroclor-1016	Marine	0.03	ug/L	USEPA 2009	FRV - AWQC
PCBs	Aroclor-1221	Marine	0.03	ug/L	USEPA 2009	FRV - AWQC
PCBs	Aroclor-1232	Marine	0.03	ug/L	USEPA 2009	FRV - AWQC
PCBs	Aroclor-1242	Marine	0.03	ug/L	USEPA 2009	FRV - AWQC
PCBs	Aroclor-1248	Marine	0.03	ug/L	USEPA 2009	FRV - AWQC
PCBs	Aroclor-1254	Marine	0.03	ug/L	USEPA 2009	FRV - AWQC
PCBs	Aroclor-1260	Marine	0.03	ug/L	USEPA 2009	FRV - AWQC
VOCs	1,1,1-Trichloroethane	Marine	312	ug/L	USEPA 2001	
VOCs	1,1,2,2-Tetrachloroethane	Marine	90.2	ug/L	USEPA 2001	
VOCs	1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	Marine	NSV	--	--	
VOCs	1,1,2-Trichloroethane	Marine	550	ug/L	USEPA 2006b	

Appendix F
Ecological Screening Values (ESVs) for Water

Analytical Group	Chemical	Type	ESV	Units	Reference	Comments
VOCs	1,1-Dichloroethane	Marine	NSV	--	--	
VOCs	1,1-Dichloroethene	Marine	2,240	ug/L	USEPA 2001	
VOCs	1,2,3-Trichlorobenzene	Marine	NSV	--	--	
VOCs	1,2,4-Trichlorobenzene	Marine	5.40	ug/L	USEPA 2006b	
VOCs	1,2-Dibromo-3-chloropropane	Marine	NSV	--	--	
VOCs	1,2-Dibromoethane	Marine	NSV	--	--	
VOCs	1,2-Dichlorobenzene	Marine	42.0	ug/L	USEPA 2006b	
VOCs	1,2-Dichloroethane	Marine	1,130	ug/L	USEPA 2001	
VOCs	1,2-Dichloropropane	Marine	2,400	ug/L	USEPA 2001	
VOCs	1,3-Dichlorobenzene	Marine	28.5	ug/L	USEPA 2001	
VOCs	1,4-Dichlorobenzene	Marine	19.9	ug/L	USEPA 2001	
VOCs	2-Butanone	Marine	NSV	--	--	
VOCs	2-Hexanone	Marine	NSV	--	--	
VOCs	4-Methyl-2-pentanone	Marine	123,000	ug/L	USEPA 2006b	
VOCs	Acetone	Marine	564,000	ug/L	USEPA 2006b	
VOCs	Benzene	Marine	110	ug/L	USEPA 2006b	
VOCs	Bromochloromethane	Marine	NSV	--	--	
VOCs	Bromodichloromethane	Marine	NSV	--	--	
VOCs	Bromoform	Marine	640	ug/L	USEPA 2001	
VOCs	Bromomethane	Marine	120	ug/L	USEPA 2001	
VOCs	Carbon disulfide	Marine	NSV	--	--	
VOCs	Carbon tetrachloride	Marine	1,500	ug/L	USEPA 2001	
VOCs	Chlorobenzene	Marine	25.0	ug/L	USEPA 2006b	
VOCs	Chloroethane	Marine	NSV	--	--	
VOCs	Chloroform	Marine	815	ug/L	USEPA 2001	
VOCs	Chloromethane	Marine	2,700	ug/L	USEPA 2001	
VOCs	cis-1,2-Dichloroethene	Marine	680	ug/L	USEPA 2006b	
VOCs	cis-1,3-Dichloropropene	Marine	7.90	ug/L	USEPA 2001	
VOCs	Cyclohexane	Marine	NSV	--	--	
VOCs	Dibromochloromethane	Marine	NSV	--	--	
VOCs	Dichlorodifluoromethane(Freon-12)	Marine	NSV	--	--	
VOCs	Ethylbenzene	Marine	25.0	ug/L	USEPA 2006b	

Appendix F
Ecological Screening Values (ESVs) for Water

Analytical Group	Chemical	Type	ESV	Units	Reference	Comments
VOCs	Isopropylbenzene	Marine	NSV	--	--	
VOCs	m- and p-Xylene	Marine	19.0	ug/L	Total xylenes	
VOCs	Methyl acetate	Marine	NSV	--	--	
VOCs	Methylcyclohexane	Marine	NSV	--	--	
VOCs	Methylene chloride	Marine	2,560	ug/L	USEPA 2001	
VOCs	Methyl-tert-butyl ether (MTBE)	Marine	5,000	ug/L	Buchman 2008	
VOCs	o-Xylene	Marine	19.0	ug/L	Total xylenes	
VOCs	Styrene	Marine	910	ug/L	USEPA 2006b	
VOCs	Tetrachloroethene	Marine	45.0	ug/L	USEPA 2001	
VOCs	Toluene	Marine	215	ug/L	USEPA 2006b	
VOCs	trans-1,2-Dichloroethene	Marine	680	ug/L	USEPA 2006b	
VOCs	trans-1,3-Dichloropropene	Marine	7.90	ug/L	USEPA 2001	
VOCs	Trichloroethene	Marine	1,940	ug/L	USEPA 2006b	
VOCs	Trichlorofluoromethane(Freon-11)	Marine	NSV	--	--	
VOCs	Vinyl chloride	Marine	NSV	--	--	
VOCs	Xylene, total	Marine	19.0	ug/L	USEPA 2006b	

NSV - No Screening Value

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Appendix G
Rationale for Soil and Sediment Outfall Sampling Locations

Appendix G

Rationale for Soil and Sediment Outfall Sample Locations

1	Evaluate surface runoff and soil deposition that may have occurred during plant operation or as a result of building demoliton from the upgrading former Building 503.
2, 3, 5, 6	Evaluate soil characteristics beneath former Building 503. No floor drains were located within this building and there was no known release associated with this area; therefore, 4 discrete sample locations are recommended to confirm no release has occurred.
4,7	Evaluate soil characteristics from the most likely loading/unloading zone associated with Buidling 503.It is unknown if a relase has occurred; therefore, 2 discrete sample locations are recommended from the area north of Buidling 503.
8	Evaluate soil characteristics beneath former Building 2007. No floor drains were located within this building and there was no known release associated with this area; therefore, 1 discrete sample location is recommended to confirm no release has occurred.
9, 11, 13, and 15	discrete sample locations are recommended within the former conveyor belt area. The two edge samples (Sample 7 and Sample 9) will be biased toward the respective buildings because it is believed to be most likely to to have received contamination based on historical operation of the conveyor system.
10, 12, and 14	Evaluate surface runoff and soil deposition that may have occurred during plant operation or as a result of building demolition from the upgradient former Building 503 and 503A conveyor belt area to the south (toward the wetlands). These samples will be placed in low lying areas where upgradient surface runoff would likely converge/collect.
16	remediated (excavated and removed) discharge area (former Site 7 area). This sample will be placed at the most upgradient point of the drainage area to confirm surface runoff and building demolition did not result in recontamination of the previously remediated drainage area.
17 and 18	Evaluate soil characteristics beneath former Building 375. No floor drains were located within this building and there was no known release within this area; therefore, 2 discrete sample locations are recommended to confirm no release has occurred.
19	Evaluate surface runoff and soil deposition that may have occurred during plant operation or as a result of building demolition from the upgradient Building 375 to the south (toward the wetland). This sample will be placed in a low lying area where upgradient surface runoff would likely converge/collect.
20, 23, and 32	within the former conveyor belt area. The two edge samples (Sample 20 and Sample 32) will be biased toward the respective buildings because it is believed to be most likely to to have received contamination based on historical operation of the conveyor system.
21, 22, 26, and 31	Evaluate soil characteristics beneath the footprint of the former conveyor belt 505A located south and west of Buildings 504/505. It is unknown if a release has occurred; therefore, 4 discrete sample locations are recommended within the former conveyor belt area.
24	Evaluate surface runoff and soil deposition that may have occurred during plant operation or as a result of building demolition from the upgradient former 502A conveyor belt area to the south (toward the wetlands). This sample will be placed in a low lying area where upgradient surface runoff would have likely converged/collected.
25	Evaluate soil characteristics at the discharge location from drainage feature located south of former Buildings 504 and 505. This sample will be collected at the base of the corrugated metal pipe extending from the base of the soil berm that connects to the concrete drainage feature located south of the buildings.
27	Evaluate soil characteristics beneath former Building 505 and former Building 505. No floor drains were located within this building and there were no known releases associated with this area; therefore, 1 discrete sample location is recommended.
28 and 29	Evaluate soil characteristics from the most likely loading/unloading zone associated with Buidlings 504 and 505. It is unknown if a relase has occurred; therefore, 1 discrete sample location is recommended from the area north of each buidling.
30	Evaluate soil characteristics beneath former Building 504 and former Building 505. No floor drains were located within this building and there were no known releases associated with this area; therefore, 1 discrete sample location is recommended.
33	Evaluate soil characteristics beneath former Building 2008. No floor drains were located within this building and a there is no known release associated with this area; therefore, 1 discrete sample location is recommended from the building footprint to confirm no release has occured.
34, 35, 38, 39	Evaluate soil characteristics beneath former Building 502. Two floor drains were located within this building; therefore, 4 discrete sample locations are recommended to determine if a release has occurred. Two of these sample locations will placed at the approximate location of the former floor drains.
36 and 37	Evaluate soil characteristics from the most likely loading/unloading zones associated with Buidling 502.It is unknown if a relase has occurred; therefore, 2 discrete sample locations are recommended from the area north of the building.
40	Evaluate surface runoff and soil deposition that may have occurred during plant operation or as a result of building demolition from the upgradient former Building 502 to the south (toward the wetlands). This sample will be placed in a low lying area where upgradient surface runoff would likely converge/collect.
Outfalls 1-4	Evaluate soil/sediment characteristics at each downgradient outfall (NR 016, 018, 018A, and 006A). One discrete sediment sample will be collected from the first depositional area downgradient of each outfall.